

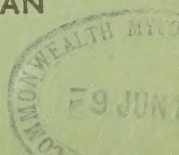
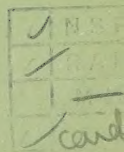
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"The reprints of my paper 'Further contributions to the fungi of West Pakistan, I' *Biologia*, 6, 1960, were received from the press on 15th December, 1960. They were dispatched to your Institute in January, 1961. The issue could not be printed as a whole...til 15th April, 1961." Extract from Dr Ahmad's letter of 3.8.61.

BIOLOGIA

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DECEMBER 1960

No. 2

Further contributions to the Fungi of West Pakistan, I

SULTAN AHMAD, D.Sc.

Department of Botany, Government College, Lahore

Since the publication of the author's "Fungi of West Pakistan" in 1956, a large amount of new material has been collected from this region, and it is proposed to deal with it in a series of papers.

The present paper, which is the first of the series, includes about a hundred species of Fungi, 26 of which are new to science while the rest are new records for this area.

The author is indebted to the Director of the Commonwealth Mycological Institute, and to Drs. R. W. G. Dennis, Emil Mueller and Ivar Jorstad, for their help in the identification of the specimens.

1. *Amphisphaeria millepunctata* (Fuck.) Petr. in *Annal. Mycol.* 21: 329, 1923.
On dead branches of *Viburnum grandiflorum*, Changla Gali, 14-8-54, No. 11029.
2. *Chaetosphaeria phaeostroma* (Dur. and Mont.) Fuck. *Symb. Myc.*, p. 166, 1869; Sacc. *Syll. Fung.* II: 93, 1883.
On dead branches of *Viburnum grandiflorum*, Patriata, Murree Hills, 20-8-53, No. 10000.
3. *Pleospora quadrisepitata* Cke. and Harkn. in *Grevillea* 14: 10, 1875; Sacc. *Syll. Fung.* IX: 876, 1891.
On dead branches of *Berberis* sp., Swat: Bahrain.
4. *Sydowina moravica* Petr. in *Annal. Mycol.* 23: 95, 1925.
On dead wood, Lun Bagla, Muzaffarabad, 5-9-55, No. 14006.
5. *Vizella appendiculosa* (Mont.) Theissen in *Broteria* 12: 20, 1940. Syn. *Asterina appendiculosa* Mont.
On fallen leaves of *Hedera himalaica*, Murree, August 1948, No. 2442.
6. *Gloniopsis biformis* (Fr.) Sacc. *Syll. Fung.* II: 773, 1883.
On dead wood of *Juglans regia*, Lun Bagla, Muzaffarabad, Sep. 1955, No. 13094.

7. *Lophiostoma angustilabrum* (Berk. and Br.) Cke.; Sacc. Syll. Fung. II: 687 as *Lophiotrema angustilabrum* (Berk. and Br.) Sacc.
On dead branches of *Indigofera gerardiana*, Kaghan Valley: Shogran.
8. *Coniochaeta malacotricha* (Niessl.) Trav.; Sacc. Syll. Fung. I: 270 as *Rosellinia malacotricha* (Auersw.) Niessl.
On dead wood, Murree, August 1954.
9. *Sordaria humana* (Fuck.) Wint. in Bot. Zeit. 30: 835, 1872.—Syn. *S. sphaerospora* Sacc. Syll. Fung. XI: 280, 1895.
On dung, Kaghan Valley: Shogran, July 1956, No. 14102.
10. *Sordaria minima* Sacc. and Speg. apud Sacc. in Michelia I: 373, 1878.—Syn. *Hypocopa minima* Sacc. Syll. Fung. I: 244, 1882.
On rabbit dung, Lahore.
11. *Pseudovalsa umbonata* (Tul.) Sacc. Syll. Fung. II: 135, 1883.
On dead branches, Swat: Kalam, 23-8-50, No. 4775.

12. ***Erysiphe sambuci* sp. nov.**

Mycelium hypophyllum vel caulicolum, candidum. Perithecia numerosa, gregaria vel dispersa, 100-150 μ diam., cellulis parietibus 11-14 μ crassitudine; appendices numerosae longitudine perithecorum simili, primo hyalinae, deinde fuscae. Asci 5-6, 60-65 μ longitudine, 32-40 μ crassitudine; sporae 3-4, 22-26 μ longitudine, 14 μ crassitudine.

Hypophyllous or caulicolous; mycelium white, forming a dense mat in the basal half or the whole of the stem, the infection on the leaves is not very severe. Perithecia abundant, gregarious or a little scattered, 100-150 μ in diameter, wall 11-14 μ thick; appendages numerous, as long as the diameter of the perithecium, at first hyaline but ultimately turning brownish, sometimes the terminal part hyaline and only the basal half brown. Asci 5-6, 60-65 μ long, 32-40 μ broad. Spores 3-4, 22-26 μ long, 14 μ broad.

On *Sambucus ebulus*, Kaghan Valley: Naran, 2-8-56, No. 14161, type.

13. *Sphaerotheca lanestris* Harkness in Bull. Acad. Sci. I: 40, 1886; Sacc. Syll. Fung. 9: 364, 1891.

Mycelium hypophyllous, brownish on young leaves but hardly visible in older ones. Perithecia formed in great abundance, 77-98 μ in diameter, dark brown to almost black; appendages very short to almost wanting; wall of the perithecium differentiated into an inner layer of large, hyaline cells, which comes out with the ascus. Ascus ovoid, 70-90 $\times$ 46-70 μ ; spores eight, 12-18 $\times$ 14-20 μ .

On leaves of *Quercus ilex*, Swat: Kalam, 20-8-52, No. 4993; Bahrain, 13-4-54, No. 10039.

14. *Sphaerotheca sanguisorbae* (DC.) Blumer, Beitr. z. Krypt.—Fl. der Schweiz, VII (1): 113, 1933.

Mycelium hypophyllous, seriously affecting the normal development of the leaves and forming a definite crust. Perithecia 76-87 μ in diameter; wall

cells up to 20μ ; appendages numerous, 3-6 times longer than the diameter of the fruitbody, thick, stiff, brown; ascus $50-70\mu$ long, $40-60\mu$ broad, mostly 8-spored. Spores often badly formed, $17-22 \times 12-15\mu$.

On *Spiraea vestita*, Kaghan Valley: Naran, 31-8-59, No. 14475.

15. *Fracchia subcongregata* (B. and C.) Ell. and Ev. North Amer. Pyren. p. 244, 1892; Sacc. Syll. Fung. XVI: 418, 1902.

On dead branches of *Viburnum grandiflorum*, Patriata, Murree Hills, 20-8-53, No. 8069; Lun Bagla, Muzaffarabad, 6-9-55, No. 13077.

16. *Coccomyces insignis* Karst. Symb. myc. XXIV: 16; Sacc. Syll. Fung. VIII: 752, 1889.

On overwintered leaves of *Carex nivalis* var. *cinnamomea* (Boott) Link and *C. cruenta* Nees, Gilgit: Naltar Valley, R. R. Stewart.

17. *Lophodermium arundinaceum* (Schr.) Chev. Flor. par, I, p. 435; Sacc. Syll. Fung. II: 795, 1883.

On leaves of *Festuca ovina*, L., Kaghan Valley: Saiful Maluk.

18. *Daldinia vernicosa* (Schw.) Ces. and de Not. Schema Sf. in Comm. critt. I, p. 198; Sacc. Syll. Fung. I: 394, 1882.

On logs, Kaghan Valley: Naran, 28-8-59, No. 14430.

It is said to differ from *D. concentrica* in the autodigestion of the stroma flesh, otherwise identical with it and therefore doubtfully distinct.

19. *Rosellinia congesta* Hino and Katamoto

On a bamboo pole, Lahore, 20-12-48, No. 2520.

20. *Diaporthe berberidis* Cooke

On dead branches of *Berberis* sp., Murree, 12-8-53, No. 8039.

21. *Scutellinia cubensis* (Berk. and Curt.) Le Gal; Sacc. Syll. Fung. VIII: 176 as *Lachnea cubensis* B. and C.

On the ground, Nathia Gali, Murree Hills.

22. *Catinella olivacea* (Batsch ex Fr.) Boud., Hist. Classif. Discom. Eur., p. 150, 1907.

On decayed logs, Kaghan Valley: Sharhan.

23. *Pezizula ocellata* (Fr.) Seaver, N. Amer. cup Fungi (Inoperculates) p. 345; Syn. *Stictis ocellata* Fr. Syst. Myc. 2: 193, 1822.

On the bark of *Salix* sp., Kaghan Valley: Shogran.

24. *Tapesia fusca* (Pers. ex Fr.) Fuck. Symb. Myc. 302, 1869.—Syn. *T. subiculata* Sacc. Syll. Fung. VIII: 380, 1889.

On decayed wood, Swat: Bahrain.

25. *Chaetoceratostroma hispidum* Turc. et Maffei, Atti Inst. Bot. Pavia XV: 144, 1912; Sacc. Syll. Fung. XXIV: 1071, 1928.

On fallen leaves of *Quercus incana*, Ghora Gali, Murree Hills, 30-8-60, No. 14768.

26. *Helotium cyathoideum* (Bull. ex Fr.) Karst. Fung. Fennica 836; Not. Soc. Fauna Fl. Fenn. 11: 237, 1871.
On dead branches of *Sambucus ebulus*, Kaghan Valley: Naran.
27. *Helotium calyculus* (Sow. ex Fr.) Fr. Summa Veg. Scand., p. 355, 1849.
On dead branches, Kaghan Valley: Naran.
28. *Helotium subferrugineum* (Nyl.) Karst. in Acta Soc. Fauna Fl. Fenn. II (6): 125, 1885.
On dead wood, Kaghan Valley: Naran.
29. *Phialea petasata* (Karst.) Sacc. Syll. Fung. VIII: 259, 1889.
On herbaceous stems, Patriata, Murree Hills.
30. *Phialea albidula* (Karst.) Sacc.
On dead branches of *Cnicus* sp., Kaghan Valley: Sharhan.
31. *Phialea cacaliae* (Pers. ex Fr.) Gillet, Champ. Fr. Discom., p. 104, 1879.
On stems of *Rumex* sp., Ghora Gali, Murree Hills.
32. *Dasyscypha arida* (Phill.) Sacc. Syll. Fung. VIII: 455, 1889.
On dead branches of *Abies pindrow*, Kaghan Valley: Naran.
33. *Dasyscypha pudibunda* (Quel.) Sacc. Syll. Fung. VIII: 433, 1889.
On dead branches, Charehan, Murree Hills.

According to R. W. G. Dennis the present collection is near this species but certainly one of the *D. Virginea* stirpes.

34. ***Entyloma cyperi* sp. nov.**

Sori epiphyllous, atris, plus minusve lineariformibus, discretis vel confluentibus, 2-5 mm. longis; sporis numerosis, globosis vel late ellipsoideis, 25-33 μ diam.; episporio 1.5 μ cr., pallidior, levis.

Sori epiphyllous, black, linear or oblong, 2-5 mm. long or by confluence covering larger part of the leaf, blackish; spores globose or broadly ellipsoid, 25-33 μ in diameter; episporio 1.5 μ thick, pallid, smooth.

On leaves of *Cyperus rotundus* Linn., Karachi, 19-5-56, No. 14111.

There exists an earlier reference to another species, viz. *Entyloma cypericola* on *Cyperus flavescens* in Zundel's Ustilaginales of the world, p. 233. This is apparently an error for *Entorrhiza cypericola* (P. Magn.) de Toni and as far as I have been able to ascertain, no species of *Entyloma* has been described for this host

35. *Tolyposporella sporoboli* H. S. Jackson apud Whetzel and Kern in Mycologia 18: 122, 1926.

Sori in sheaths and blades, forming black striae of varying lengths, ultimately rupturing to expose the black spore mass. Spores subglobose to ovoid, dark reddish brown, with the thin outer wall running into a point and the swollen inner wall, 2-4 μ thick, 12-16 μ in longer diameter.

On *Sporobolus marginatus* Hochst., Ladhar, Sheikhpura, 9-8-50, No. 3087; 15-9-49, No. 2736.

36. *Entyloma speciosum* Schroet. and P. Henn. in Hedwigia 35: 220, 1896.

Sori foliicolous, long covered by the epidermis; spores polyhedral to almost irregular, $12-16\mu$ in diameter.

On *Alopecurus nepalensis* Linn., Lahore, 28-3-57.

37. *Entyloma microsporum* (Unger) Schroet. in Rabenh. Fungi eur. No. 1872, 1874.

Sori foliicolous, forming reddish brown, hard pustules; spores hyaline or slightly tinted, oblong to subglobose, $12-20\mu$ long.

On leaves of *Ranunculus* sp., Lahore, 28-12-56, No. 14176.

38. *Tilletia decipiens* (Pers.) Koern. in Hedwigia 16: 30, 1877.

Sori ovaricolous, concealed by the glumes; spores reddish brown or golden brown, globose or subglobose, reticulate, the reticulations more conspicuous near the margin, $24-28\mu$ in diameter.

On *Agrostis canina* Linn., Kaghan Valley: Naran, 30-8-59, No. 14465.

39. *Ustilago striaeformis* (Westend.) Niessl. in Hedwigia 15: 1, 1876.

Sori foliicolous, forming long black streaks, several centimeters in length, at first covered by the epidermis then becoming exposed; spores globose to $9-14\mu$ in ellipsoid, echinulate, $9-14\mu$ in diameter.

On *Agrostis stolonifera* Linn., Murree, Sep. 1957, leg. Asghar Ali.

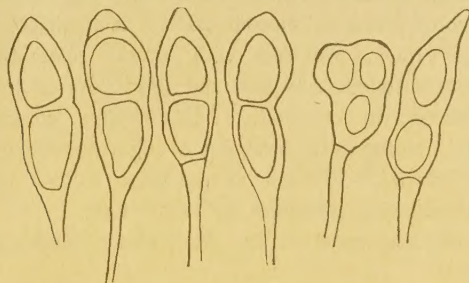


Fig. 1. *Puccinia cypericola*. Teleutospores, $\times 500$.

40. *Puccinia cypericola* sp. nov.

Soris uredosporiferis hypophyllis, linearibus, seriatis, 1.5-4 mm. longitudine, saepe confluentibus, fuscis, pulverulentibus. Uredosporis globosis vel subglobosis, $20-25 \times 15-20\mu$; membrana pallida brunnea vel flava, 1.5μ crassa, verruculosa, poris germinationis 2, aequatorialibus. Teleutosporis oblongis vel clavatis medio constrictis, $50-56 \times 16-23\mu$, apice attenuatis, membrana brunnea, apice ad 15μ incrassata et hyalina. Pedicello usque ad 50μ longo.

Uredia hypophyllous, linear, seriatly arranged, 1.5-4 mm. long or longer by confluence, brown, pulverulent. Uredospores globose or subglobose, verruculose, pale brown or somewhat yellowish, $20-25 \times 15-20 \mu$; epispore $2-2.5 \mu$ thick, with 2 equatorial germ pores. Teleutospores developing in uredosori, oblong to clavate, constricted at the septum, apex conical, thickened to 15μ , hyaline, $50-56 \times 16-23 \mu$, yellowish brown; pedicel $36-50 \mu$ long.

On *Cyperus rotundus* Linn., Peshawar, 20-9-56, No. 14112, leg. M. A. F. Faridi, type.

The uredospores correspond to those of *Puccinia conclusa* Thuem. (syn. *P. romagnoliana* Maire & Sacc.), but the teleuto-stage does not. Most of the teleutospores possess a sort of beak and they develop in the uredosori.

41. *Puccinia pakistani* sp. nov.

Soris uredosporiferis hypophyllis, flavis, prima tectis demum erumpentibus et epidermide circumdatis, seriatis, 0.5-2 mm. longis, confluentibus. Uredosporis globosis, ovatis vel ellipsoideis, $20-26 \mu$ diam., membrana hyalina, verruculosa, 1.5μ crassa, poris germinationis numerosis, dispersis. Soris teleutosporiferis nigris, tectis. Teleutosporis clavatis vel ellipsoideis, $40-60 \times 15-24 \mu$, apice truncatis vel attenuatis; basi attenuatis, medio non vel leniter constrictis. membrana flavo-fusca, $3-5 \mu$ crassa. Pedicello flavo, ad 10μ elongato, persistent.

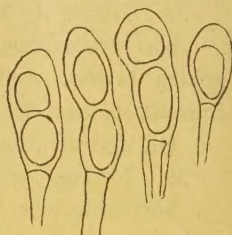


Fig. 2. *Puccinia pakistani*.
Teleutospores $\times 500$.

Uredosori hypophyllous, yellowish when dry, rather long covered and then surrounded by the ruptured epidermis, seriatly grouped, 0.5-2 mm. long, becoming confluent. Uredospores globose, ovate or ellipsoid, $20-26 \mu$ in diameter; epispore hyaline, verruculose, 1.5μ thick, provided with many, scattered germ pores. Teleutosori similar but black, compact and long covered by the epidermis. Teleutospores clavate to ellipsoid, $15-24 \times 40-60 \mu$, conical, rounded or truncate apically, tapering to the base, not or slightly constricted at the septum, wall yellowish brown, $3-5 \mu$ thick at the sides, $8-12 \mu$ thick at the apex, smooth; pedicel yellowish, persistent, up to 10μ long.

On leaves of *Carex nubigena* D. Don, above Nathia Gali, Sep. 1957, No. 14728, type.

The present species differs from *Puccinia caricis-nubigenae* Padw. & Khan in the uredospores possessing many scattered germ pores.

42. *Puccinia penniseti-lanati* sp. nov.

Soris uredosporiferis hypophyllis, seriatis, minutis, 0.5-1 mm. longis, solitaris vel confluentibus, epidermide circumdatis, flavis. Uredosporis globosis vel subglobosis vel ellipsoideis, $14-18 \times 16-24 \mu$, membrana hyaline, 1.5μ crassa, leniter verruculosa, poris germinationis dispersis. Teleutosoris tectis, nigris. Teleutosporis pyriformis, flavo brunneis, medio constrictis, $20-27 \times 30-40 \mu$, apice rotundatis, ad 6.5μ incrassatis; pedicello ad 10μ longo.

Uredosori hypophyllous, seriatly arranged, minute, 0.5-1 mm. or longer by confluence, surrounded by the ruptured epidermis, golden coloured.

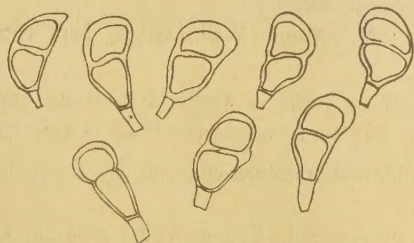


Fig. 3. *Puccinia penniseti-lanati*. Teleutospores, $\times 500$.

Uredospores globose or subglobose or ellipsoid, $14-18 \times 16-24\mu$; episore hyaline, 1.5μ thick, finely verruculose, with scattered germ pores. Teleutosori long covered by epidermis, black. Teleutospores pyriform, smooth, yellowish brown, constricted at the septum, $20-27 \times 30-40\mu$, apex rounded, up to 6.5μ thick; pedicel up to 10μ long.

On leaves of *Pennisetum lanatum* Klotz., Kaghan Valley: Batakundi, 28-8-49, No. 2845, type.

The present species is quite distinctive in having golden coloured uredia and the telia long covered by the epidermis.

43. *Puccinia carthami* var. *oxyacanthae* var. nov.

A typo differt poris germinationis 3, aequatorialibus.

It differs from the species in having 3, instead of 2, equatorial germ pores.

On *Carthamus oxyacantha* Bieb., Sangla Hill, 20-3-52.

44. *Puccinia behenis* Otth, Mith., Naturf. Ges. Bern, 1870, p. 113, 1871. Teleutospores $30-40 \times 20-44\mu$, with $1.5-2.5\mu$ thick wall.

On *Silene aucheriana* Boiss., Quetta; *Dianthus anatolicus* Gilgit: Naltar Valley; *Cerastium* sp., Miranjani near Nathia Gali.

45. *Puccinia heterospora* Berk. & Curt. in Jour. Linn. Soc. Lond. 4: 91, 1873.

Teleutospores of two kinds, 1-celled and 2-celled, the former $26-30 \times 16-20\mu$, with the side wall 3μ thick and the apex up to 13μ thick; the latter $30-35 \times 23-25\mu$, the septum usually oblique or vertical, the side wall 6μ thick and the pedicel hyaline, excentric, up to 85μ long.

On *Sida veronicaefolia*, Saidpur near Rawalpindi, Sep. 1954, leg. R. R. Stewart.

46. *Puccinia monticola* Komarov in Script. Bot. Univ. Petropol, IV, 2: 29, 1895; Sacc. Syll. Fung. XVI: 304, 1902.

Teleutospores ellipsoid or oblong-ellipsoid, $28-33 \times 16-20\mu$, the side wall up to 1.5μ thick and the apex up to 6.5μ thick, chestnut brown, densely verrucose, esp. the upper cell.

On *Polygonum* aff. *filicaule* Wall., Gilgit, Sep. 1956, No. 14746, leg. Shaukat Ali.

47. *Puccinia sibirica* Tranz. in Tranz. & Serebrian., Mycoth. Ross. fasc. III-IV, No. 160, 1911; Sacc. Syll. Fung. XXIII: 765, 1925.

Teleutospores ellipsoid or oblong-ellipsoid, $23-30 \times 16-20\mu$, with numerous scattered warts.

On *Polygonum alpinum* All., Kaghan Valley : Naran, 30-8-59, No. 14748.

48. *Puccinia dioicae* P. Magn. s. 1.

The uredospores possess 2 top placed germ pores.

On leaves of *Carex nubigena* D. Don, Kaghan Valley: Sharhan, 30-8-59, No. 14729.

49. *Puccinia cyrnea* Maire in Bull. Soc. Bot. de Fr. 47 : 216, 1901; Sacc. Syll. Fung. XVII: 368, 1905; S. Ahmad, Biologia 2 : 57, 1956 as *P. junci*.

Dr. Ivar Jorstad points out that the material collected from Quetta appears to be most like *P. cyrnea* Maire, which undoubtedly is allied to *P. littoralis* Rostr. (syn. *P. junci* Wint.) and probably has similar host alternation. In his opinion it cannot be referred to *P. cancellata* Sacc. & Roum. (syn. *P. rimosa* Wint.).

50. *Puccinia aeluropidis* Ricker in Jour. of Myc. 11: 114, 1905; Sacc. Syll. Fung. XXI: 712, 1912 as *P. aeluropi*.

Uredospores $19-24 \times 20-25\mu$, cinnamon brown, epispore $2-2.5\mu$ thick, provided with 3-4 equatorial germ pores. Teleutospores $40-50 \times 20-24\mu$, wall chestnut brown, 2μ thick at the sides, $5-9\mu$ thick at the apex; pedicel up to 100μ long.

On *Aeluropus macrostachyus* Hack., Quetta, Maslakh Range, May 1957, R. R. Stewart; Sep. 1959, M. Sharif.

51. *Puccinia oplismeni* H. & P. Syd. in Ann. Myc. 5 : 498, 1907; Sacc. Syll. Fung. XXI : 702, 1912.

Teleutospores chestnut brown, $30-36 \times 15-20\mu$, wall 8μ thick at the apex; pedicel persistent, 80μ long.

On *Oplismenus* sp., Ghora Gali, Murree Hills, March 1957, No. 14338, leg. Asghar Ali Chaudhuri.

The uredospores are not present in this collection, but besides teleutosori are present brown, capitate paraphyses which no doubt belong to the disappeared uredo-stage. The rust probably belongs to the present species, but for this no uredo-stage has so far been recorded.

52. *Uromyces ciceris-soongaricae* sp. nov.

Soris teleutosporiferis hypophyllis et cauliculis, 0.5-2 mm. longis, epidermide tectis, brunneis. Teleutosporis irregulariter ovatis vel ellipsoideis, pallida brunneis $26-50 \times 20-30\mu$, apice rotundatis vel truncatis, rare attenuatis, ad 10μ incrassatis; pedicello hyalino, ad 50μ longo, deciduo.

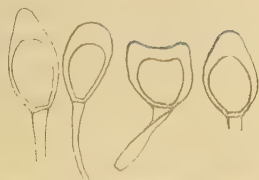


Fig. 4. *Uromyces ciceris-soongaricae*, Teleutospores, $\times 500$.

Telia hypophyllous and cauliculous, 0.5-2 mm. in length, covered by the ruptured epidermis, dark brown. Teleutospores very variable in shape, ovate to ellipsoid, pale brown, $26-50 \times 20-30\mu$, apex rounded or truncate, sometimes almost conical, thickened to 10μ ; pedicel hyaline, up to 50μ long, fragile.

On *Cicer soongarica*, Base Camp, Bad Swat, 27-9-57. No. 14760, leg. Shaukat Ali, type.

53. *Uromyces sophorae* sp. nov.

Aecidiis hypophyllis, minutis, dense aggregatis, cupulatis; cellulae peridialae rhomboidaleae, $23-36 \times 16-20\mu$, membrana exteriore $5-6\mu$ crassa, striata, membrana inferiore $3-5\mu$ crassa, verruculosa. Aecidiosporis angulo-globosis, $18-22\mu$ diam. vel ellipsoideae $15-18 \times 12-14\mu$, membrana $2-2.5\mu$ crassa, pallida flavis, echinulatis. Soris teleutosporiferis solitaris vel confluentibus, 0.5-2 mm. diam. epidermide fissa cinctis, brunneis. Teleutosporis ovatis vel oblongis, rare subglobosis, rubrofusis, $16-18 \times 20-26\mu$, membrana 3.5μ crassa, apice papillata; pedicello hyalino, deciduo.



Fig. 5. *Uromyces sophorae*, teleutospores, $\times 500$.

Aecia hypophyllous, minute, gregarious, cupulate, peridial cells rhomboid, $23-36 \times 16-20\mu$, outer wall $5-6\mu$ thick, striate, inner wall $3-5\mu$ thick, coarsely verrucose; aecidiospores angulo-globose, $18-22\mu$ in diameter or ellipsoid, $15-18 \times 12-14\mu$, epispore $2-2.5\mu$ thick, pale yellowish, finely verrucose. Teleutosori amphigenous, solitary or confluent, 0.5-2 mm. in diameter, covered by the ruptured epidermis, chestnut brown. Teleutospores ovate or oblong, sometimes almost spherical, reddish brown, $16-18 \times 20-26\mu$, epispore 3.5μ thick, apex papillate, the papilla about 3.5μ ; pedicel hyaline, deciduous.

On leaves of *Sophora alopecuroides* L., Gilgit: Naltar Valley, 6-9-56, No. 14757, leg. Shaukat Ali, type.

An opsis-form like this has not been described so far for *Sophora* (incl. *Cladrastis*).

54. *Uromyces penniseti* sp. nov.

Soris uredosporiferis amphigenis, fere hypophyllis, 0.5-2 mm. longis, saepe confluentibus, seriatis, fuscis. Uredosporis globosis vel ovatis, $20-26\mu$ diam., membrana echinulatis, $1.5-2\mu$ crassa, hyalina, poris germinationis 4-5, dispersis. Soris teleutosporiferis numerosis confluentibus. Teleutosporis globosis vel ovatis, apice rotundatis vel attenuatis, basi rotundatis, $20-33 \times 16-23\mu$, membrana rubro-fusca, apice ad 10μ incrassata, pedicello persistenti, $40-80\mu$ longo, pars apicale brunneo, pars basale hyalino et collapsio.

Uredia amphigenous, mostly hypophyllous, 0.5-2 mm. long, becoming much longer by confluence, seriatly arranged, cinnamon brown. Uredospores globose or ovate, $20-26.5\mu$ in diameter; epispore echinulate, $1.5-2\mu$ thick, hyaline, provided with 4—5 scattered germ pores; paraphyses wanting. Teleutosori similar, occupying by confluence larger part of the leaves and leaf-sheaths. Teleutospores globose to ovate, apex rounded or conical, thickened to 10μ , base rounded or attenuated, smooth, reddish brown, usually darker at the apex, $20-33 \times 16-23\mu$; pedicel persistent, $40-80\mu$ long, hyaline and collapsing except for a shorter portion near the point of attachment which is also concolorous with the spore.

On *Pennisetum lanatum* Klotz., Kagan Valley: Naran, 29-8-59, No. 14434, type.

55. *Uromyces laburni* (DC.) Otth, Mitth. Naturf. Ges. Bern, 1863, p. 87.

Syn. *U. genistae-tinctoriae* Winter in Hedwigia 19: 36, 1860.

Uredospores globose to oval, with 2.5μ thick wall and 5-6 scattered germ pores. Teleutospores $20-22 \times 13-16\mu$, closely verrucose, the warts not arranged in longitudinal rows, side wall 1.5μ thick, the apex 2μ thick; pedicel short.

On *Caragana ambigua*, Ziarat, Quetta, 2-9-59, No. 14721, leg. A.H. Khan.

56. *Uromyces salsolae* Reich., Verh. K. k. Zool.-Bot. Ges. Wien, 27 : 842, 1877.

Teleutospores ovate or subpyriform, rounded at the apex, thickened to 6.5μ at the apex, smooth, $26-32 \times 16-20\mu$, pedicel up to 200μ long. Uredospores sub-globose to almost spherical, $22-26 \times 22\mu$; epispore 1.5μ thick, provided with 4-5 germ pores.

On *Salsola kali*, Quetta, 15-6-59, No. 14759, leg. A. H. Khan.

The present collection differs from *U. chenopodii*, to which *U. salsolae* is usually referred as a synonym, in having larger teleutospores and very long pedicels and the apex thickened to 6.5μ . In West Pakistan, *U. chenopodii* is a common rust infecting *Suaeda fruticosa* but it does not produce any teleuto-stage.

57. *Uromyces heliotropii* Svedenski in Issatschenko, Parasit. Pilze Gouv. Cherson. 1896, p. 229; Sacc. Syll. Fung. XIV : 278, 1899.

Uredia hypophyllous or caulicolous, scattered or in orbicular clusters, 0.5-1 mm. in diameter, covered by the ruptured epidermis, cinnamon. Uredospores obovate, pyriform or ellipsoid, finely echinulate, pale brown, $23-30 \times 20-24\mu$, epispore 1.5μ thick, provided with 2 super-equatorial germ pores.

On *Heliotropium dasycarpum* Ledeb., Gilgit : Karga Nala, 2-9-56, No. 14789, leg. Shaukat Ali,

58. *Uredo abietina* sp. nov.

Spermogonia adsunt. Uredosori principales hypophylli, 1-3 mm. longitudine, saepe confluentes, 0.3-0.5 mm. crassitudine, epidermide tecti. Uredosporae globosae, subglobosae, vel obovatae, dense aculeatae, $22-25 \times 15-16\mu$.

Spermogonia present. Uredosori hypophyllous, 1-3 mm. long, sometimes even longer by confluence, 0.3-0.5 mm. broad, covered by epidermis. Uredospores globose or subglobose, densely echinulate, $22-23 \times 15-16\mu$.

On leaves of *Abies pindrow* Spach, Dunga Gali, Murree Hills, 15-6-58, No. 12284, leg. Mohsin Nawaz, type.

Dr. Ivar Jorstad remarks that "the present rust consisting of spermogonia and primary uredosori appears to be closely allied to *Uredo holwayi* Arth. on *Tsuga heterophylla* and *Ts. mertensiana* in Western N. America. This rust has by Arthur been placed in the form-genus *Uraecium*, but there is no reason for maintaining this as a separate form-genus against *Uredo*".

59. *Coryneum piricola* sp. nov.

Pustulae discoidiformes, innatae, erumpentes, 1 mm. diam., atrae. Sporae fusiformes, 3-5 septatae, non constrictae, saepe curvatae, olivaceo-fuscae, $40-60\mu$ longitudine et $22-24\mu$ crassitudine, loculi crassae tunicati, sporophori rigidi, breves, ca. 6.5μ longitudine.

Pustules discoid, innate-erumpent, 1 mm. broad, black. Spores broadly fusoid, 3 to 5-septate, not constricted, sometimes slightly curved, olivaceous-fusuous, $40-60 \times 22-24\mu$, each loculus thick walled, with a round or angular lumen; sporophores stout, short, 6.5μ long.

On dead branches of *Pyrus* sp., Swat: Bahrain, 14-8-52, No. 14031, type.

Those already described on this host are not good *Coryneum* species whereas this is a true *Coryneum*.

60. *Cercospora cadabae* sp. nov.

Maculae primo rotundae demum confluentes, formes irregularibus, flavae, 2-20 mm. diam; conidiophori fasciculatae, epidermidem erumpentes, recti vel leniter curvatae, $10-15 \times 2.5\mu$, conidia filiformia, hyalina, 1-3 septata, recta vel leniter curvata, $20-45 \times 2.5-3\mu$.

Spots amphigenous, at first circular later becoming confluent and irregular, yellowish, 2-20 mm. wide; conidiophores very densely tufted, rupturing the epidermis, regular to subflexuous, $10-15 \times 2.5\mu$ conidia filiform, hyaline, 1-to-3-septate, straight or slightly curved, $20-45 \times 2.5-3\mu$.

On living leaves of *Cadaba farinosa*, Changa Manga, Lahore, 24-3-54, No. 9061, type.

The fungus produces discoloration of a larger part of the leaf and causes severe defoliation. At the time of collection the host plants were almost naked with heaps of infected leaves lying under them.

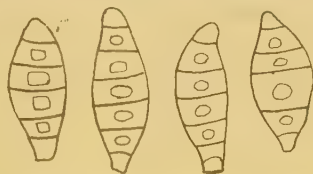


Fig. 6. *Coryneum piricola*, spores, $\times 500$.

61. *Davisiella botryodiplodiae* sp. nov.

Pycnidia globosa, stroma innata, 90-108 μ diam., paries 12-14 μ crassitudine, flavus, plectenchymaticus. Sporae ellipsoideae vel fusiformes, extremis angustis, hyalinae, 8-11 μ longitudine, 3-3.5 μ crassitudine.

Pycnidia globose or subglobose, within the stroma of the host, 90-108 μ in diameter; wall 12-14 μ thick, yellowish, plectenchymatous; spores elliptic-fusiform, narrowed towards the two ends, 1-septate, hyaline, 8-11 μ long, 3-3.5 μ broad.

On *Botryodiplodia* sp., on dead branches, Murree, August 1948, No. 2412, type.

62. *Stagonospora eriobotryae* sp. nov.

Pycnidia ca. 400 μ diam., fusca, separata, ostiolum epidermidem perforat, globosum. Conidiophori breves. Conidia hyalina, 2-3-cellulata, cylindracea vel ellipsoidea, 23-26 $\times$ 4 μ .

Pycnidia up to 400 μ in diameter, dark, separate, only the ostiole breaking through the epidermis, globose, ostiolate; conidiophores short; conidia hyaline, typically 2-3 celled, cylindrical to elliptic, 23-26 $\times$ 4 μ .

On fallen leaves of *Eriobotrya japonica*, Salt Range: Choa Saidan Shah, 13-3-50, No. 3101, type.

***Suttonia* nom. nov. Syn. *Pseuderiospora* Petr. non Keissl.**

The generic name *Pseuderiospora* was proposed by Petrak in 1959 in Sydowia 13, p. 109 with *P. gaubae* Petr. as the type species. However, the generic name *Pseuderiospora* was pre-occupied, having been erected by Keissler in 1923 in Anzeiger Akad. Wiss. Wien Nr. 11, p. 75. The name *Pseuderiospora* Petr., therefore, becomes a homonym and it is necessary to replace it. I propose to call it *Suttonia* in honour of Mr. B. C. Sutton of the Commonwealth Mycological Institute, Kew. This change further necessitates the following new combination.

***Suttonia gaubae* (Petr.) comb. nov.**

Syn. *Pseuderiospora gaubae* Petr. Sydowia 13 : 109, 1959.

A second species of this genus has been collected on *Eriobotrya japonica* and is being described here as new.

63. *Suttonia eriobotryae* sp. nov.

Pycnidia atra, dispersa, ellipsoidea, 625-875 μ longitudine, subepidermalia. Stratum tegens carbonaceum ad 30 μ crassitudine; stratum basale 50-100 μ crassitudine, cellulis parenchymaticis 5-15 μ diam. compositum. Conidiophori apice duobus conidiis, hyalini, 13.5-25 $\times$ 4.5-5 μ . Conidia hyalina, cylindraceo-fusiformia, 20-30 $\times$ 4.5 μ .

Pycnidia black, hypophyllous, scattered, broadly oval in outline with rounded ends, $625-875\mu$, subepidermal, covering layer heavily carbonized, up to 30μ thick, basal layer formed of superposed cells, $50-100\mu$ thick, the individual cells $5-10 \times 5-15\mu$; conidiophores bearing 2 conidia apically, hyaline, simple, obconical, $13.5-25 \times 4.5-5\mu$; conidia hyaline, cylindric-fusiform, $20-30 \times 4.5\mu$; the conidiophore and the conidia together forming a triradial structure.

On fallen leaves of *Eriobotrya japonica*, Salt Range: Choa Saidan Shah, 13-3-50, No. 3101, type.

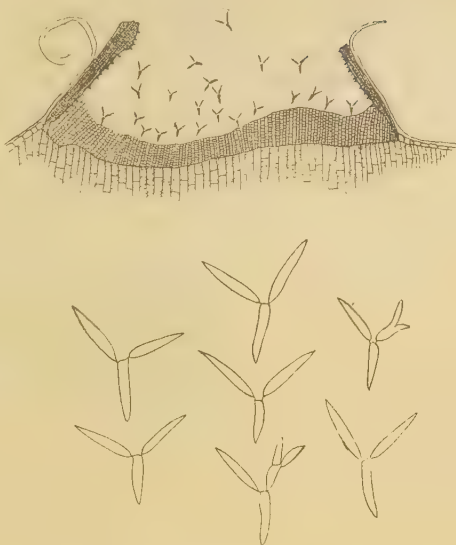


Fig. 7. *Suttonia eriobotryae*. V. S. pycnidium, $\times 70$; conidia, $\times 400$.

64. *Ascochyta skimmiae* sp. nov.

Pycnidia epiphylla, dispersa, globosa, erumpentia, atra, 120μ diam., ostiolo. Paries fuscus, parenchymaticus, ca. 12.5μ diam. Conidia hyalina, fusiformia, 1-septata, non constricta, $11-12 \times 2.5\mu$.

Pycnidia epiphyllous, scattered, globose, innate-erumpent, ostiolate, blackish, 120μ in diameter; wall dark brown, parenchymatous, complete; spores hyaline, oblong-fusiform, 1-septate, not constricted at the septum, $11-12 \times 2.5\mu$.

On fallen leaves of *Skimmia laureola*, Changla Gali, Murree Hills, 14-8-54, No. 14834, type.

65. *Hendersonia panici-antidotatae* sp. nov.

Pycnidia erumpentia, dispersa, subglobosa, atra, ad 150μ diam., ostiolo. Paries parenchymaticus, ca. 8.5μ crassitudine. Conidia cylindracea vel fusiformia, extremis rotundatus, flava, 1-septata, demum 2-3-septata, $6.5-13.5 \times 2.5\mu$.

Pycnidia innate-erumpent, scattered, subglobose, blackish, up to 150μ in diameter, ostiolate; wall parenchymatous, up to 8.5μ thick; conidia cylindric-fusoid, rounded at the ends, yellowish, 1-septate, then 2 and finally 3-septate, $6.5-13.5 \times 2.5\mu$.



Fig. 8.
Hendersonia
panici-antidotatae.
Conidia $\times 800$.

On culms of *Panicum antidotale* Retz., Ladhar, Sheikhpura, 18-8-47, No. 2007; Lahore, 15-11-53, No. 4227, type.

66. *Trullula pulvinata* sp. nov.

Acervuli aggregati, erumpentes, saepe confluentes, atri. Conidia brunnea, $6-13 \times 5-10\mu$, in catenis clavatis, $35-60 \times 5-10\mu$.

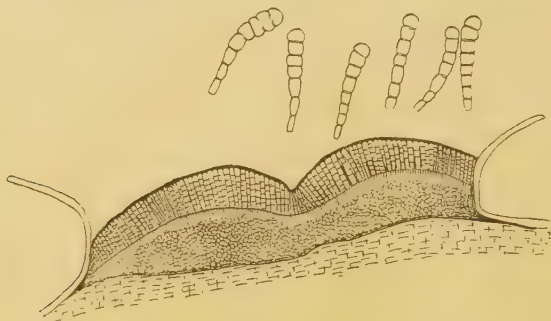


Fig. 9. *Trullula pulvinata*. V. S. acervulus, $\times 85$; spores $\times 300$.

Acervuli gregarious, innate-erumpent, sometimes confluent, dark. Spores catenate, very variable in shape and size, $6-13 \times 5-10\mu$; the chains formed of 5-9 spores, clavate, gradually tapering downwards $35-60 \times 5-10\mu$, light brown.

On dead branches of *Spiraea* sp., Murree, May 1951, No. 4341, type.

The spores are of an unusual shape for the genus *Trullula* of which no species has been recorded on *Spiraea*.

67. *Steganosporium fici* sp. nov.

Acervuli subgregares, erumpentes, fuscii, pulvinoformes. Conidia oblongo fusiformia, septis transversis 3-5, septis longitudinalis 2-4, brunnea, $20-40 \times 13-24\mu$.



Fig. 10. *Steganosporium fici*. Conidia, $\times 600$.

Acervuli subgregarious, innate-erumpent, dark, cushion-shaped. Conidia oblong-fusoid, muriform, with 3-5 transverse and 2-4 longitudinal septa, light brown, $20-40 \times 13-24\mu$.

On dead branches of *Ficus palmata*. Swat : Bahrain, 13-4-54, No. 9093, type.

68. *Steganosporium parottiae* sp. nov.

Acervuli erumpentes, atrii, pulvino-formes. Sporae oblongae vel ovoideae, muriformes, brunneae, $25-50 \times 13-25\mu$.

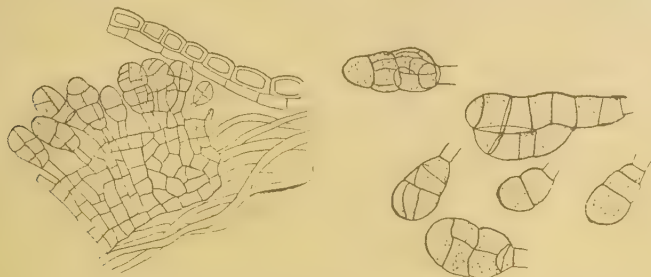


Fig. 11. *Steganosporium parottiae*. V. S. acervulus, $\times 150$; conidia, $\times 600$.

Acervuli innate erumpent, dark, cushion shaped. Conidia muriform, ovoid or oblong, $25-50 \times 13-25\mu$, brown.

On dead branches of *Parottia jacquemontii*, Swat: Kalam, 23-8-52, No. 4776, type.

69. *Phoma saccharicola* sp. nov.

Pycnidia erumpentia, 150μ diam., globosa, ostiolo ad 25μ longitudine; paries parenchymaticus, ca. 10μ crassitudine; conidia ellipsoidea, hyalina, non septata, $6.5-8 \times 2-2.5\mu$.

Pycnidia innate-erumpent, 150μ in diameter, globose, ostiolo up to 25μ long, wall parenchymatous, up to 10μ thick; conidia ellipsoid, hyaline, unseptate $6.5-8 \times 2-2.5\mu$.



On dead culms of *Saccharum munja* Roxb., Ladhar, Sheikhupura, 26-9-50, No. 4247, type.

Fig. 12. *Phoma saccharicola*. Conidia, $\times 750$.

70. *Cytoplea zizyphina* sp. nov.

Stroma dothioidis, innata, erumpens, atra, 0.6-2 mm. longitudine; loculi numerosi, irregulares vel globosi, flavo-fusci, $142-285 \times 114-242\mu$, parietibus parenchymaticis, 20-25 μ crassitudine. Paraphyses absunt. Sporae ovoideae vel ellipsoideae, flavo-fuscae, $5-6.5 \times 3\mu$.

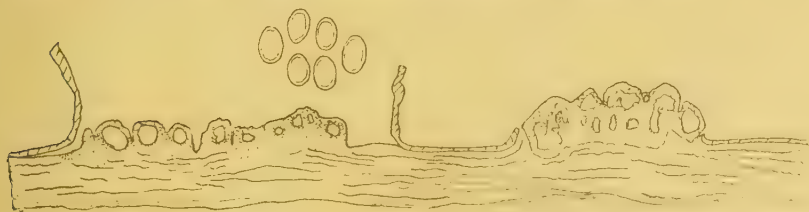


Fig. 13. *Cytoplea zizyphina*. V. S. stroma, $\times 25$; spores, $\times 800$.

Stroma dothidioid, innate-erumpent, black, 0.6-2 mm. long, loculi several, monostichous, irregular to almost globose, yellowish brown, with parenchymatous walls, $142-285 \times 114-242\mu$, wall $20-25\mu$ thick; paraphyses wanting; spores ovoid or ellipsoid, almost filling the loculi, yellowish brown, non-septate, $5-6.5 \times 3\mu$.

On dead branches of *Zizyphus sativa*, Kagan Valley: Paras, 23-8-49, No. 2897, *Z. oxyphylla*, Swat: Khaza Khela, 16-4-54, No. 10006, type.

71. *Cytoplea parasitica* sp. nov.

Stroma superficiem plantae fere tegens, loculi subglobosi vel pyriformes, plerumque latere compressi, brunnei, $175-360 \times 110-200\mu$, parietibus parenchymaticis, ad 20μ crassitudine; paraphyses absunt; sporae ellipsoideae, subfuscus, non septatae, $8-10 \times 5-5.5\mu$.



Fig. 14. *Cytoplea parasitica*. V. S. stroma $\times 25$, spores $\times 800$.

Stroma superficial, covering almost the entire surface of the host; pycnidia polystichous, subglobose to pyriform, mostly laterally compressed, brownish, with parenchymatous wall, $175-360 \times 100-200\mu$; paraphyses wanting; spores elliptic, pale brown, non-septate, $8-10 \times 5-5.5\mu$.

On *Hypoxylon rubiginosum* Pers. ex Fr. on *Viburnum grandiflorum*, Murree, 23-8-53, No. 9065, type.

72. *Bispora catenula* (Lev.) Sacc. Syll. Fung. IV: 344, 1886.

On fallen leaves of *Quercus dilatata*, Murree, August 1948, No. 2441.

73. *Sphaeropsis polyanthina* sp. nov.

Pycnidia erumpentia, subglobosa. $250-300 \times 120-130\mu$; paries parenchymaticus, $10-12.5\mu$ crassitudine; conidia globosa, ellipsoidies. $13-20 \times 12-14\mu$, non septata.

Pycnidia innate-erumpent, depressed-globose, $250-300 \times 120-130\mu$; wall parenchymatous, $10-12.5\mu$ thick; conidia globose, oval or ellipsoid, $13-20 \times 12-14\mu$, unseptate, slightly tinted.

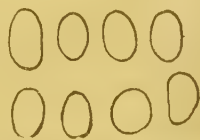


Fig. 15. *Sphaeropsis polyanthina*. Conidia, $\times 500$.

On stems of *Polyanthes tuberosa*, Bot. Gard. Lahore, 12-11-55, No. 14024, type.

74. *Hendersonia sacchari-spontanei* sp. nov.

Pycnidia innata, erumpentia, 100-300 μ diam., globosa; parietibus parenchymaticis, 10-12 μ crassitudine. Conidia 3-septata, subfusca, 11-13 $\times$ 4-5 μ , pedunculata, verrucosa, verrucae ordinibus longitudinalibus.

Pycnidia innate-erumpent, 100-300 μ in diameter, globose or subglobose, wall parenchymatous, 10-12 μ thick; conidia 3-septate, yellowish brown, verrucose, the warts arranged in longitudinal rows, 11-13 $\times$ 4-5 μ .

On culms of *Saccharum spontaneum*, Lahore, 29-2-48, No. 2277, type.

75. *Hendersonia letendrzana* Sacc. var. *convolvuli* var. nov.

Fig. 16
Hendersonia
sacchari-spontanei.
Conidia, $\times$ 650.

Closely resembles the species in the size of the spores (25-30 $\times$ 4 μ) but the septation is almost constantly 5 as against 3-4 given in the original description.

On branches of *Convolvulus arvensis*, Swat : Khaza Khela, 15-4-54, No. 9079.

76. *Diplodia cassiae-multijugae* P. Henn. in Hedwigia 48 : 112, 1908; Sacc. Syll. Fung. XXV: 280, 1931.

On pods of *Cassia* sp., Changa Manga, Lahore, 19-3-50, No. 3145.

77. *Chaetostroma atrum* Sacc. Michelia II: 174; Syll. Fung. IV: 749, 1886.

On culms of *Saccharum munja*, Ladhar, Sheikhpura, 15-9-47, No. 2110.

78. *Stilbella erythrocephala* (Ditm.) Lindau in Nat. Pflanzenf. 1: 1, 489, 1900.

On richly manured soil, Lahore, 15-2-57, No. 14608.

79. *Oidium curtisii* (Berk.) Linder in Lloydia 5: 201, 1942. - Syn. *Rhinotrichum curtisii* Berk. N. Amer. Fung. No. 657; Sacc. Syll. Fung. IV: 93, 1886.

On dead wood, Changa Manga, Lahore, 4-11-50, No. 3051; 10-1-54, No. 9003.

80. *Oidium curtisii* (Berk) Linder var. *ovalisporium* Linder in Lloydia 5: 204, 1942.

On a decayed log, Patriata, Murree Hills, 18-8-54, No. 14737.

81. *Oidium aureo-fulvum* (Cooke & Ellis) Linder in Lloydia 5: 189, 1942. Syn. *Monilia aureo-fulva* Cooke & Ellis in Grevillea 8: 12, 1879; Sacc. Syll. Fung. IV: 331, 1886.

On dead wood, Murree, 22-8-52, No. 2861.

82. *Sporodum atropurpureum* Berk. and Curt. North Amer. Fung. No. 653.-Syn. *Dematium atropurpureum* (B. and C.) Sacc. Syll. Fung.

IV: 308, 1886.

On peelings of *Saccharum officinarum* and on culms of *S. munja*, Ladhari, Sheikhupura, 10-9-49, No. 2763.

83. *Camptomeris albizziae* (Petch) Mason apud Hansford in Proc. Linn. Soc. London 1942-43, p. 61, 1943.-Syn. *Helminthosporium albizziae* Petch.

On living leaves of *Albizzia lebbek*, Changa Manga, Lahore, 5-12-54, No. 14030.

84. *Phyllosticta hedericola* Dur. and Mont. Syll. p. 279; Sacc. Syll. Fung. III : 20, 1884.

On leaves of *Hedera himalaica*, Murree, August 1948, No. 2727.

85. *Leptostroma caricinum* Fr. Syst. Myc. 2 : 598; Sacc. Syll. Fung. III : 645, 1884.

On leaves of *Carex nivalis*, Gilgit : Naltar Valley.

86. *Titaosporine tremulae* (Lib.) Luyk in Ann. Myc. 17 : 112, 1919. Syn. *Leptothyrium tremulae* Lib.

On leaves of *Populus ciliata*, Murree, 22-9-49, No. 2901.

87. *Alt ernaria tenuissima* (Nees ex Fr.) Wilts. in Trans. Brit. Myc. Soc. 18: 157, 1933.

On fruit of *Luffa* sp., Rawalpindi, 20-3-54, No. 13023; on a dead branch of *Hibiscus esculentus*, Lahore, 22-1-50, No. 3030 (together with *curularia spicifera* (Bain.) Boedijn); on leaves of *Tabernaemontana* sp., Lyallpur, 28-11-54; of *Berberis* sp., Lahore, 19-3-50.

88. *Cylindrocolla cylindrophora* Ell. and Ev. Jour. of Myc. 1886, p. 39; Sacc. Syll. Fung. X: 715, 1892.

On cone scales of *Pinus excelsa*, Ghora Gali, Murree Hills, April 1957, No. 14753.

89. *Circinotrichum inops* Berl. Fung. Mor. Fasc. III; Sacc. Syll. Fung. IV: 314, 1886.

Sterile hyphae erect, septate, verrucose, $140 \times 4.5 \mu$, olivaceous brown at the base and fading upwards, dichotomously branched, the tips of the branches nearly hyaline, coiled at the tips; conidiophores short, hyaline, $6.5 \times 3 \mu$; conidia cylindric-fusiform, hyaline, straight, $14.5 \times 2.5 \mu$.

On fallen leaves of *Quercus dilatata*, Murree, August 1948, No. 2444; Ghora Gali, April 1955, No. 14754.

90. *Stigmata quercina* (Wakefield) M.B. Ellis in Myco. Pap. C. M. 1., 72, p. 61, 1959. Syn. *Pucciniopsis buercina* Wakef.



Fig. 17. *Circinotrichum inops*, sterile hyphae, $\times 300$, conidia, $\times 600$

On fallen leaves of *Quercus dilatata*, Murree (No. 14559).

91. *Haplosporella macluræ* (Cke.) Petr. and Syd. in Ann. Myc. 22 : 67, 1926.

On dead branches of *Maclura aurantium*. Changa Manga, Lahore.

92. *Cercospora jujubæ* Chowdry in Ind. Jour. Agric. Sci. 16: 525, 1926; Chupp, Monogr. of the Genus *Cercospora*, p. 469, 1953.

On leaves of *Zizyphus jujuba* Lamk., Lahore, 19-11-50, No. 3076.

93. *Diplodia hortensis* Sacc. Jour. of Myc. 13: 47, 1907; Sacc. Syll. Fung. XXII: 989, 1913.

On dead branches of *Clematis* sp., Ghora Gali, April 1957, No. 14819.

94. *Mystrosporium pyriforme* Desm. XIV Not. p. 13; Sacc. Syll. Fung. IV: 541, 1886.

On dead branches of *Eryngium coeruleum*. Swat: Khaza Khela 15-4-54, No. 9081.

95. *Corynespora cassicola* (Berk. and Curt.) Wei in Mycol. Pap., C.M.I., 34, p. 5, 1950-Syn. *Helminthosporium cassicolum* Berk. and Curt., Cuban fung. No. 628; Sacc. Syll. Fung. IV: 419, 1886.

On dead branches of *Clerodendron inerme*. Lahore, 22-10-48, No. 2503; 9-1-49, No. 2542.

96. *Septonema exaltatum* Petch in Ann. Roy. Bot. Gard. Peradeniya VII (4): 318, 1922.

On the ground, Nathia Gali, 27-9-49, No. 2372.

97. *Arthrinium spagazzinii* Subraminian in Proc. Ind. Acad. Sci. Sect. B, 44: 122, 1956 Syn. *Microtypha saccharicola* Speg. in Anal. Mus. Nac. Buenos Aires 20 : 432, 1910. Sacc. Syll. Fung. XXII: 1352, 1913.

On culms of *Saccharum spontaneum*, Lahore, 19-11-50, No. 3073.

98. *Torula herbarum* Link ex Fr. f. *quaternella* Sacc. Syll. Fung. XXV: 759, 1931.

On dead branches, Lahore, 22-10-48, No. 2501.

99. *Discosia jambolanae* sp. nov.

Pycnidia separata, epiphylla, dispersa, innato-terumpentia, discoidea, 1.2-1.5 mm. diam., fusca; conidia hyalina, oblonga vel fusiformia, 1-septata, 13-15 × 4-5 μ , flagello ab utraque parte.

Pycnidia epiphyllous, scattered, subepidermal, discoid, 1.2-1.5 mm. in diameter, black; wall parenchymatous, yellowish brown 10 μ thick; conidiophores all along the wall, short; conidia hyaline, oblong to fusoid, 1-septate, ciliate with 2 cilia at the upper end and 1 cilium at the lower end, 13-15 × 4-5 μ .

On fallen leaves of *Eugenia jambolana*, Sialkot, 15-11-58, No. 14297 ; of *Mangifera indica*, Sialkot, 15-11-58, No. 14312.

100. ***Stilbum mycetophilum* sp. nov.**

Sparsum v. laxissime subgregarium, exicatum capucine yellow (R), pediculus cylindraceus, parte superiore extendet capitulum sporidia ferentem formentem. Sporae hyalinae, 1-cellulatae, ovoideae, pituitosae, $3.5-5 \times 2\mu$.

Fruitbody scattered or subgregarious, light coloured, capucine yellow (R) when dry, stalk cylindric, 0.8 mm. long, expanding above into an ovoid or rounded head, $150-250\mu$ in diameter, spores hyaline, 1-celled, ovoid, $3.5-5 \times 2\mu$.

On *Poria* sp., Changa Manga, Lahore, 19-10-58, No. 14263, type.

On some fungi producing phenolic esters

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Until recent times only one species of fungi has properly been known to produce some sweet-smelling, aromatic substances giving a characteristic odour to the decayed wood. The fungus in question is a Holarctic Polyporaceae, *Lentinus lepideus* Fr., distributed widely at least in Europe and in North America, and infecting felled as well as worked coniferous timber.

The smell produced by that fungus resembles cinnamon or Peru balsam. The aromatic substances elaborated by *Lentinus lepideus* Fr. are esters of various phenolic acids, the methyl *p*-methoxycinnamate being probably the principal and potentially final non-oxidized product to which the characteristic smell is particularly due. The remaining aromatic substances found in the culture of the fungus would be methyl cinnamate and a methyl ester of anisic acid produced by oxidation of Me *p*-methoxycinnamate [Birkinshaw and Findlay 1940], and furthermore esters of isoferulic and *p*-coumaric acids respectively [Shimazono 1959]: the methyl isoferulate and methyl *p*-coumarate.

These aromatic substances become important in the study of the mechanism of lignification since there exists a similarity of the structure of methyl *p*-methoxycinnamate [as produced by the fungus from glucose-containing media] with the structures of certain lignin building stones [Nord and Schubert, 1959]. Methyl *p*-coumarate may be methylated to methyl *p*-methoxycinnamate in vivo, the process showing besides a reversibility. Hence such methylation and demethylation of phenolic esters are of interest from view-point of both the mechanism of lignification and the metabolism of phenolic substances by wood-destroying fungi.

As pointed out in my recent articles [Paclet 1954, 1960], the production of the same or nearly related aromatic substances is remarkably not confined to fungi inhabiting coniferous timber.

As early as in 1952-1953, I observed the first case of a decay of the hardwood characterized by a strong cinnamic smell. Further research showed that the fungus responsible for the sweet aroma was *Pleurotus ulmarius* [Bull. ex Fr.]. Extracts with ether or building water retained the aroma of methyl *p*-methoxycinnamate [Paclet 1954, pp. 51-52]. Matrix: Elm [*Ulmus carpiniifolia* Gled.], samples showing a heart-hold decay ["Kernschale" or "Schälrisigkeit"].



Fig. 1. D'ie back of a tree of *Paulownia tomentosa*. Hodonin, Czechoslovakia. Photo [Mrs.] V. Paclt.



Fig. 2. Tip of the same *Paulownia* tree. The arrow indicates the insertion place of the best developed fructifications of *Trametes gallica*. Photo [Mrs.] V. Paclt.

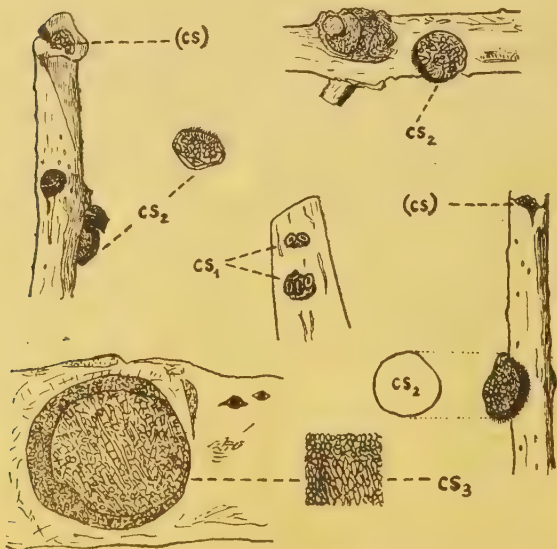


Fig. 3. A quite mature fructification [CS₄] of *Trametes gallica*. Coll. Botanical Dept. National Museum, Praha. Photo [Mrs.] V. Paclt.



Fig. 4. Various stages of fructifications of *Trametes gallica*; [CS] = carposomata overgrowing secondarily the transverse sections of twigs; CS₁, CS₂, CS₃, = carposomata of the natural surfaces of twigs [initial premature and submature stages]. J. Paclt del.

Later in 1959, I investigated an interesting case of die-back of a Far East tree, *Paulownia tomentosa* [Thnbg.]. The most striking feature of the wood-decay observed was again a strong cinnamic smell due to phenolic esters produced by the hyphae of *Trametes gallica* [Fr.]. This species of Polyporaceae seems to occur frequently even in Asia; dr. A. Pilát of National Museum, Prague, met with it, in June 1959, in Samarkand [Uzbek region of the Russian Central Asia] where *Trametes gallica* [Fr.] grew on *Morus alba* L. [Verbal communication]. The accompanying figures [fig. 1-4], not published before, may now complete my article on the die-back of *Paulownia tomentosa* [Thnbg.] observed in a park cultivation at Hodonin, Czechoslovakia [Paclt 1960].

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Notes on Some Trichurids

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Trichuris trichiura (Linnaeus 1771) (Fig. 1)

The species is known to occur in man, pig, wild boar and various types of monkeys. The species originally described from man contains a number of synonyms, such as, *T. palaeformis* (Rud.), *T. lemuris* (Rud.), *T. simiae* (Rud.), *T. suis* (Schränk), *T. apri* (Gmelin), *T. crenatus* (Rud.), *T. dispar* (Rud.), and *T. hominis* (Goeze). Recently, a new species has been added to this group under the name of *Trichuris cynocephalus* by Khera (1951). This author has obviously altogether overlooked the original works on the subject and has based his species on characters which have from time to time been discussed to be extremely variable.

Among the authors who have pointed out the variability of such characters in *Trichuris* of man, pig and monkey are: Rudolphi (1809), Creplin (1825), Leuckart (1876), and Schwartz (1926). Creplin (1825) concluded that *Trichuris* from man is the same as that found in pig and wild boar. He found the spicular sheath to be very variable. Schneider (1866) concluded that *Trichuris* from man and other primates was the same. Schwartz (1926), after a study of *Trichuris* material from man, pig and monkey concluded that *Trichuris* from all these sources was identical. On the other hand, some evidence has been advanced to show that the *Trichuris* from man is distinct from that of swine. In this context, Pavlovski and Sondak (1951) give an account of the controversy on the validity of human and swine whipworms and have quoted 20 relevant references. The *Trichuris* from man and swine are considered distinct by Pavlovski and Sondak (1951), for the following reasons: The chromosome number is 4 in the human species and 6 in the swine species (Dinnik, 1938); the two species do not give rise to cross infection and the statistical data for the two species are different.

As the species, *T. cynocephalus* (Khera, 1951) does not morphologically differ from the variations described in *T. trichiura* the validity of this species is linked up with the validity of *Trichuris* from man, swine and other primates. But, even if the *Trichuris* species from man and primates were found to be distinct in due course of time, the validity of *T. cynocephalus* will require further investigation, because of a number of species described from primates and treated at present as synonyms of *T. trichiura*. This position has obviously

been altogether overlooked by Khara (1951), while describing his species.

The following description of the species is recorded from a study of some material deposited by Lane in the British Museum (Natural History). The material had been labelled as originating from "*Sus bengalensis*, near Dinapore, Bihar" and man, "Berhampore". The measurements, unless stated otherwise, are in millimeters.

MALE : Length of anterior portion 22-25; length of posterior thick portion 13-14. Dujardin (1845) quoted the anterior portion as 22 and the posterior as 15. Chandler (1930), however, quoted the posterior thick portion as 11.5-14.5 and the anterior oesophageal portion as about one and one half to two times this length. Again, Sprehn (1932) and Neveu Lemaire (1936) both quoted the length as 30-45, the ratio between the anterior oesophageal and posterior thick portions being 3 : 2. The body width was found to be the greatest in the region of the junction of seminal vesicle and ejaculatory duct measuring 0.65, while the width in the middle of ejaculatory duct region was 0.57 and in the middle of cloaca as 0.45.

The spicule measured 2.025-2.8 long (length quoted by Sprehn (1932) as 2-3.35; breadth measured 0.07 in the proximal half and 0.04 in the distal half. The author did not find many specimens with everred spicular sheaths, but, according to Dujardin (1845), the shape of the sheath varies from being cylindrical to a more or less dilated one in the form of funnel, or, swollen and vesicular at the extremity.

The seminal vesicle measured 3-5.5 and the ejaculatory duct 2.0-4.25 long. The ejaculatory duct show long epithelia in its lumen but apparently no muscles in its wall. The cloaca is highly muscular and measured 2.5-3.47 long. The spicular diverticulum was found to join the cloaca at a distance of 1.1-1.5 from the posterior end. Chandler (1930) described the ejaculatory duct as about 2.9-3.4 long and compared it as hardly more than half as long, sometimes much less than half as long, as the "vas deferens". The "vas deferens" was recorded by him as 5-8 long. Quite obviously, Chandler's measurements of "vas deferens" represent the combined measurements of seminal vesicle and the spermatid duct from the point of its turning near the junction of oesophagus and intestine.

The testis starts near the commencement of cloaca and is convoluted throughout its course.

The cloacal opening is subterminal and is bounded by a pair of cloacal papillae.

FEMALE : Anterior portion of the body 22-30 long and the thick posterior 10-13 long. Sprehn (1932) and Neveu Lemaire (1936) both described the body as 35-50 long with a ratio between the anterior and posterior portions being 2 : 1. The body width in the distal half of the thick portion was

found to be more or less uniform and measured 0.75-0.82. The shape of the vagina showed differences depending on the state of contraction of the coils. The eggs measured $0.05-0.054 \times 0.02-0.0275$.

The anterior portion shows, in both sexes, two rows of vesicles along the bacillary band starting at a distance of 0.5 from the anterior end. The anterior end is furnished with a retractile spear which was described by Kuchenmeister (1857) in the following words, "We often perceive, at the extreme tip of the head, the protrusion of a small, hyaline, onion-like structure, which passes off in an obtusely conical form anteriorly." Li (1933), again, described and illustrated its presence without being aware of Kuchenmeister's account.

Trichuris hystricis Kreis, 1938 (Fig. 2)

The species was described by Kreis, 1938 from *Hystrix cristata* which died in Basle. The following description is based on one male and one female from the type collection deposited by Kreis in the Basle Museum. The measurements from Kreis, 1938 are recorded in parentheses, below. All measurements are in millimeters unless stated otherwise.

MALE : Anterior thin portion 25 long and that of the posterior thick 16. Kreis (1938), however, stated the length of the body as 37.4-45.7 and having a ratio of 1 : 1.7-2.3 between the anterior thin and posterior thick portions. The body width was found to be 0.25 at the downward turn of the spermatic duct and it increased to 0.55 near the commencement of seminal vesicle. The maximum width was attained near the junction of seminal vesicle and ejaculatory duct where it was recorded as 0.6. This width was, however, uniformly maintained, posterior to the junction, for the greater part of the body. Kreis recorded the width as $342-405\mu$ at the posterior end of the oesophagus, $595-683\mu$ as the maximum and $192-213\mu$ at the hind end of the body.

The spicule measured 1 ($896-1212\mu$) long and showed a thickness of 0.025 ($17.4-30.2\mu$) in the middle. The spicule has blunt distal end. The spicular sheath is described by Kreis, 1938 as relatively short being of the size of half the length of spicule and enlarged at the hind end like a bulb. The shaft of the sheath measured 0.09 (85.2μ) in diameter and the swelling 0.18 ($170.5-244\mu$).

Kreis (1938) failed to describe the internal genitalia of the species. In the specimen studied, the combined length of spermatic duct from its turning and the seminal vesicle was 7.4, the seminal vesicle occupying about half the length. The ejaculatory duct measured 3.65 long and appeared to be devoid of any musculature. The seminal vesicle and ejaculatory duct are joined by a distinct muscular sphincter. The strongly muscular cloaca

measured 4.8 long with the spicular diverticulum joining it at a distance of 0.85 from the posterior end.

The testis starts near the junction of cloaca and the ejaculatory duct and is moderately convoluted throughout the entire length.

The opening of the cloaca is subterminal.

FEMALE : Body length about 40 (39.42-45.70) with a ratio between the anterior and posterior portions as 1:1.5 (1:1.3-2). Body width in the region of the posterior end of oesophagus 0.2 (320-450 μ), in the region of vulva 0.22 (363-511 μ), maximum (at the middle of uterus) 0.6 (788-940 μ). The body tapers distally to a blunt end. The vagina measured 1.2 long and is highly characteristic. It consists of a proximal long, tubular narrow portion and a distal short and wide portion. Both the portions are lined with spines. The eggs measured 0.053×0.02 (43.5 61×26 -30.5 μ),

Trichuris mettami Baylis, 1935 (Fig. 3)

The species was described by Baylis 1935 from a hedgehog from Uganda. The author gave a satisfactory description but failed to provide the necessary illustrations. The following description is based on paratype specimens (1♂, 1♀) which were deposited by Dr. Baylis in the British Museum. Measurements by Baylis, 1935 are quoted in parentheses and all measurements are in millimeters.

MALE : Total length (27-38), anterior oesophageal portion (16-22), length of posterior portion 11.7, maximum thickness of the body 0.65 (0.6-0.7).

The spicule measured 3.4 (3.5-3.8) long and 0.07 (0.07-0.09) thick in the proximal third and 0.03 (0.04-0.05) in the distal two-thirds. It terminates distally in an acute blunt point. The combined length of spermatic duct from the point of its turning and the seminal vesicle measured 4.82. The ejaculatory duct measured 3.07 (3.3-4) long. The cloaca measured 3.9 (4.2-4.9) long with the spicular diverticulum joining it at a distance of 2.0 (2-2.6). The seminal vesicle is a very broad tube and is joined to the equally broad ejaculatory duct by a narrow short constriction. The inner lining of the ejaculatory duct is lined with long cilia. The spicular sheath consists of a proximal tubular and a distal globular expansion. The proximal tubular portion measured 1 long and had a diameter of 0.1. This portion is studded with closely set spines. The distal expansion, on the other hand, is devoid of spines and showed a diameter of 0.325 (0.4).

The testis starts near the junction of the cloaca and the ejaculatory duct and becomes closely coiled soon after its commencement and it is uniformly convoluted through its course.

The cloacal opening is subterminal in position.

FEMALE : Length (36-47), anterior oesophageal portion (24-29), length of posterior portion 17 and the maximum body thickness 0.73 (0.76-0.8). The vagina consists of a broad dilated proximal portion, a middle narrow straight and a distal portion coiled a few times. The vagina measured 3.1 (2.5-3) long. The anus is subterminal and the tail is rounded. The eggs measured 0.05 (0.054-0.061) long and 0.025 (0.026-0.029) broad.

The anterior portion of the body shows vesicles along the bacillary band, in both the sexes.

Trichuris peramelis Baylis, 1932 (Fig. 4)

The species was described by Baylis, 1932, from a bandicoot from Australia. One male and one female paratypes from the same collection were studied through the courtesy of British Museum authorities and the account, along with measurements in millimetres by Baylis, 1932 in parentheses, is as follows:

MALE : Anterior oesophageal portion 10.28 (8.1-10.7) long; posterior thick portion 4.46 (3.3-4) long; maximum thickness of the body 0.225 (0.22-0.24); spicule 1.9 (about 2) long and 0.013 thick in its middle and bluntly pointed at its distal end. The spicular sheath consists of a proximal tubular portion closely set with spines and a large distal smooth expansion. The ejaculatory duct is thin walled measuring 0.77 (0.8-0.9) and joined by a long distinct constriction to the seminal vesicle measuring 1.5 (0.7-1.4) long. The cloaca measured 1.17 long with the spicular diverticulum joining it at a distance of 0.325 (0.34-0.42) from the hind extremity. The cloacal opening is subterminal.

FEMALE : Anterior oesophageal portion 12 (8.3-14.5) long and posterior thick portion 5.38 (2.7-5.5); maximum thickness of the body 0.25 (0.19-0.33). The vagina measured 0.82 (0.5-0.7) long and consists of two distal curves and a more or less straight proximal portion. The eggs are globular in shape and measured about 0.045×0.03 ($0.053 \times 0.028-0.03$). The hind end of the female body is rounded and projected into a terminal papilla carrying the anal opening on its ventral surface. The posterior thick portion of the female body is club shaped with the maximum thickness attained near the hind end.

No plaques or vesicles were seen along the bacillary band in the anterior thin portion of the body, in both the sexes.

Trichuris marsupialis Foster, 1939 (Fig. 5)

Three out of four species of *Trichuris* described from *Didelphis*, namely, *T. marsupialis*, *T. urichi* and *T. reesali* are very closely related. Wolfgang (1951) who described *T. urichi* and *T. reesali* from *Didelphis*

marsupialis insularis remarked that "*T. reesali* and *T. urichi* are most closely related to *T. marsupialis*". The vagina in *T. reesali* is somewhat longer than those of *T. marsupialis* and *T. urichi* but the differences between *T. urichi* and *T. marsupialis* are limited to the vulva being 'salient and smooth' in *T. marsupialis* and 'papillate and salient' in *T. urichi*. Amongst the specimens in the collection of Prof. J. J. C. Buckley from *Didelphis* from Trinidad, it is very difficult to see, in some specimens, the papillae on the vulvar prominence but they can always be made out on a careful examination. As there are no tangible differences in the two species, viz. *T. marsupialis* and *T. urichi*, the species are considered here as synonymous.

The following description is based on material collected by Prof. J. J. C. Buckley from Trinidad. All measurements are in millimeters.

MALE : Length of anterior thin portion 9-12 and that of posterior thick portion 6-7. The thickness of the posterior portion measured about 0.5. The spicule measured 0.79-0.95 long and 0.01 thick in the middle, terminating in an acute blunt point. The spicular sheath showed variable forms, ranging from tubular to forms with rounded distal swellings. The sheath, in all its forms, was found studded with triangular spines in its proximal portion but the distal portion was either devoid of spines or showed minute spines on its surface.

The seminal vesicle measured 0.9-1.5 long and the ejaculatory duct 1.5-2.3 long. The internal lining of the ejaculatory duct was found set with long epithelia and the wall appeared to be devoid of any musculature. The cloaca measured 0.6-0.75 long and have thick walls. The spicular diverticulum was found to join the cloaca at a distance of 0.29-0.35 from the posterior end.

There is a pair of conical papillae located at the cloacal opening.

FEMALE: Length of anterior thin portion 11-14 and that of the posterior thick portion 5-7. The vagina, in all the specimens examined, had a constant shape measuring about 0.5-0.6 long and joining the uterus after a sinuous course. The anus is subterminal in position. The eggs measured $0.06-0.055 \times 0.033-0.037$.

Rudolphia vulpis (Froehlich, 1789) Sarwar, 1959 (Fig. 6)

Froehlich (1789) originally described this species from the caecum of a fox. Since then, according to Dujardin (1845), "it was reported from dog from Vienna Museum where it was collected on four occasions on a dissection of one hundred and forty four animals but it was not found on dissection of sixty-two foxes." (Free translation).

The following account is based on a study by the writer of a

collection from United States given to the British Museum by M. C. Hall. All measurements are in millimeters.

MALE : Length of anterior portion of body 35-42 and that of posterior thick 13-17.5. Neveu Lemaire (1936) gave the total measurement as 45-75 long with the oesophageal portion occupying $\frac{3}{4}$ of the body length. Chandler (1930) gave the length of posterior portion as 17-18.5 and described the oesophageal portion as a little over twice the length of posterior portion. The greatest body width is reached in the middle of cloaca and measured about 0.49.

The spicule measured 7.64-8.5 long. The length of the spicule was stated, respectively, as 9-11 and 8.6-11 by Neveu Lemaire (1936) and Chandler (1930). The thickness of the spicule measured 0.05-0.06 at the proximal portion, 0.025-0.03 at the middle and 0.02 near the distal end. The distal end of the spicule is bluntly truncated. The spicular sheath fits the spicule very closely; it is tubular in shape and measures 2.9 long. It is studded with minute spines throughout its course. The diameter of the sheath increases slightly distally, measuring 0.03 at the base and 0.04 at the distal end. Dujardin (1845), quoting Rudolphian information, described the sheath as tubular or club-shaped and in a 0.62 long sheath, the diameter was found to be 0.046 at the base and swollen up to 0.125 at the distal end.

The combined length of spermatic duct from the point of its turning and the seminal vesicle was 2.75-4.99 long and that of ejaculatory duct 1.5-1.85. Chandler (1933) stated the length of the ejaculatory duct as a little over 2 and described it as less than half the length of the "vas deferens" with which it is connected by a muscular constriction. Obviously Chandler's "vas deferens" consists of the seminal vesicle and the backwardly running portion of spermatic duct. The cloaca is exceptionally long in this species, extending about half the length of the thick portion of the body and measuring 6-10 long. The cloaca has a highly muscular wall, while the ejaculatory duct appears to be devoid of musculature.

The testis is more or less straight throughout the course and shows some kinky folds in the later part of the course.

The cloacal opening is bordered by a papilla on either side.

FEMALE: Anterior oesophageal portion 32-35.5 long and the posterior thick portion 11-16 long; maximum thickness of the posterior portion at about the middle 0.415. The vagina is very short measuring 1.15 long and shows wavy curves in the distal half. The eggs measured $0.07-0.077 \times 0.033-0.035$. Neveu Lemaire quoted the measurements as $74-90 \times 32-36\mu$.

The anus is subterminal.

There are vesicles along the bacillary band in the anterior portion of both the sexes. This character was observed in this species by Rudolphi as quoted by Dujardin (1845).

Buckleyuris cervicaprae (Kreis, 1935) Sarwar, 1959 (Fig. 7)

The species was described by Kreis (1935) from *Antilope cervicapra* which had died in the Zoological Gardens, Basle. Ortlepp (1937) described the species *Trichuris barbertonensis* from ox from Transvaal. The drawings of the caudal ends of the males of *B. cervicaprae* (Kreis, 1935) and *T. barbertonensis* show a striking resemblance to each other. Again, Ortlepp failed to compare his species with *B. cervicaprae* although he elaborated in his text a comparison of his species with *B. ovis* and *B. globulosa* with which his species has a rather remote resemblance. It is obvious that Ortlepp (1937) was not aware of the existence of *B. cervicaprae*. The author, while on a visit to Neuchatel and Holland, looked for this species and found it present in the only local collection of Trichurids at the Institute of Zoology, Neuchatel. Again, the species was present in 4 of the collections (2 from giraffe and 2 from *Camelus dromedarius*) in Utrecht and Rotterdam.

Ezzat (1945) wrongly identified specimens of *B. cervicaprae* as *B. ovis*. It appears that he had no idea of either *B. cervicaprae* or *barbertonensis*. Ezzat did realise the differences between his material and the published descriptions on *B. ovis*, but he appears to have attached no importance to these differences in the taxonomic differentiation. As, however, "*T. ovis*" of Ezzat is, beyond any doubt, identical with *B. cervicaprae*, the following hosts listed under *T. ovis* by Ezzat, should be treated as hosts of *B. cervicaprae*.

Damaliscus korrigum, *Ourebia montana*, *Gazella dorcas*, *Gazella soemmerringi*, *Gazella leptoceros*, *Gazella albonotata*, *Capra nubiana*, *Hippotragus equinus*, *Giraffa camelopardalis*, *Gazella rufifrons*. Ezzat also identified this species from sheep from Cairo abattoir.

The following study is based on a collection originating from a 4 months old *Ovis musimon* which had died in the Zoological Gardens, Basle, and 2 collections from each of giraffe and *Camelus dromedarius* from the Zoological Gardens of Utrecht and Rotterdam. The collection from *Ovis musimon* also contained specimens of *B. ovis*, *B. globulosa* and *Salamia skrjabini* (Baskakov). The collections from giraffe were found to be composed entirely of this species while the collections from camels also contained specimens of *B. globulosa*. The measurements from the material along with those from Kreis, 1935 and Ortlepp 1937, are reproduced in the accompanying table for comparison,

TABLE SHOWING MEASUREMENTS OF *BUCKLEYURIS CERVICAPRAE*

(All measurements in millimeters except, where otherwise indicated)

<i>Male</i>	Kreis, 1935	Ortlepp, 1937	Author
Length of anterior thin portion	...	...	42-50
Length of posterior thick portion	...	11-13	12-14
Maximum thickness of the body	...	...	0.6
Length of spicule	5.26	6.83-7.30	5.25-6.22
Thickness at the middle portion of spicule	...	0.014-0.016	0.015
Thickness near the distal end of spicule	12 μ	...	...
Length of spicular sheath	1.95	2.7	2.0-2.8
Breadth of spicular sheath	37 μ	...	0.03-0.035
Length of spines on the spicular sheath	...	0.005-0.01	0.004-0.005
Length of seminal vesicle	...	3.7-3.9	4.7-5.0
Length of ejaculatory duct	...	7.7-8.7	7.45-7.75
Length of cloaca	...	3.8	2.15-4.3
<i>Female</i>			
Length of anterior portion of body	...	...	38-44
Length of posterior thick portion	...	11-15	11-14
Maximum thickness of body	...	0.5	0.54-0.7
Eggs, length $\times$ breadth	62-74 $\times$ 31-35 μ	0.046-0.052 $\times$ 0.022-0.024	0.055-0.07 $\times$ 0.025-0.035

MALE : The body thickness varies in different parts, the maximum being attained in the region of the junction of seminal vesicle and ejaculatory duct. The body decreases in proportions on both sides of this point and is reduced to half the maximum thickness at the junction of the anterior thin and posterior thick portions, and in the region of the junction of ejaculatory duct and cloaca. The spicule is slender and gradually tapers posteriorly and ends distally in a sharp point. The spicular sheath is long and slender and has a uniform diameter throughout its length. The sheath is covered with dense spines which are backwardly directed. The ejaculatory duct has thick muscular wall and is joined to the seminal vesicle by a distinct muscular constriction (sphincter). The testis starts in the region of cloaca, is more or less straight in the region of ejaculatory duct and closely convoluted in the region of the seminal vesicle and spermatic duct.

FEMALE : The maximum thickness of the body is attained in the region of the junction of vagina and uterus. The vagina is regularly convoluted, increasing in diameter anteriorly. Its internal lining is studded with very fine spines in the distal half and with papillae in the proximal half of the portion. The vagina was not found everted in the immature specimens examined by the authors. The portion of the body accommodating the vagina measured 3.0-4.5 mm.

The species *B. cervicaprae* appears to be quite common in Europe and was evidently noticed by both Nitzsch and Rudolphi. Quoting Dujardin

(1845) "Nitzsch en a rencontré ensuite dans le chevreuil (*Cervus capreolus*) deux femelles, l' une longue de 50 mm. avec la partie postérieure long de 13 mm. 5, l' autre long de 40 mm, at dont la partie postérieure a 11mm, 20. Rudolphi en a aussi examiné des mâles et des femelles trouvés par Bremser dans le chamois (*Antilope rupicapra*), et dont la partie postérieure formait les deux neuvièmes de la longueur totale; les mâles longs de 47 mm, avaient l' organe génital plus long que celui des trichocéphales du mouton et du veau, *la gaine était mince, assez longue, courbée dans l' un et droite dans l' autre; les femelles étaient longues de 60 mm*" (italics mine).

Buckleyuris ovis (Abildgaard, 1795) Sarwar, 1959 (Fig. 8)

Buckleyuris ovis is a classical example of this group and it has been one time or another confused with most of the other species of the genus. So much so, that, in many cases, one should be justified in assuming that while indicating the presence of *T. ovis* no specific identity was implied. A list of hosts from which the species has been recorded from time to time, is appended and this list is sufficient to illustrate the confused situation. Whereas *B. ovis* appears to be restricted to ruminants and, geographically, to temperate regions, it has erroneously been recorded from all sorts of hosts from all over the world. The situation is being clarified gradually and it would appear probable that *B. ovis*, on critical re-examination of material, may not be as common in America and Australia, as generally implied. For illustration, *B. globulosa* (Linstow) was recorded as recently as 1949 from China and Spain. In both the countries, *B. ovis* was the only species of the genus previously known from ruminants.

The following description is recorded from a collection from a "lamb, caecum, Rooke Junr" from the British Museum (Natural History). All measurements are in millimeters.

MALE: Body length 42-48 at the anterior portion and 14-16 long at the posterior portion. The body reaches its maximum thickness near the junction of seminal vesicle and ejaculatory duct where it is 0.5. The spicule is 4.77-5.7 long and 0.022-0.025 thick at about the middle. The width at the proximal portion is about 0.125. The spicule ends distally in a blunt end. The spicular sheath is long, about 1.45 when fully stretched and consists of a proximal shaft of uniform width measuring about 1.2 long and 0.06 broad. The spines on the shaft are larger than those on the bulb.

The muscular ejaculatory duct measured 5.49-7.24 and seminal vesicle 6.35-8.35 long, and the two portions are connected by a distinct and short muscular sphincter. The cloaca measured 2.9-3.68 with the spicular diverticulum joining it 1.7-2.27 from the posterior extremity. The testis starts

at about 3.5 from the posterior extremity, is straight in the region of cloaca and greater portion of ejaculatory duct and closely coiled in the region of the seminal vesicle.

FEMALE : Body length 34-42 at the anterior portion and 15-18 at the posterior portion. The vagina is slightly everted at the vulva and is regularly sinuous throughout the course of its length. The anus is terminal and the eggs measured about 0.08×0.04 .

The anterior end, in both sexes, is furnished with a hyaline collar.

HOST LIST OF *BUCKLEYURIS OVIS*

<i>Alces</i>	Luhe, 1905	<i>Camelus</i>	Ransom, 1911
	Heinemann, 1937		Enigk, 1933
	Ransom, 1911		Parodi and Widakowitch, 1917
	Brandstetter, 1939		
<i>Llama</i>	Walton, 1928	<i>Bos</i>	Schwartz, 1925
<i>Cervus</i>	Ransom, 1911		Chen, 1937 (buffalo)
	Brumpt, 1911	<i>Blastocervus</i>	Ransom, 1911 (Pampas deer)
	Muller, 1894		
	Alderson, 1951	<i>Dama</i>	Rud, 1819
<i>Odocoileus</i>	Hall, 1925		Thwaite, 1926
	Canavan, 1946	<i>Gazella</i>	Gebauer, 1933
<i>Oryx</i>	Walton, 1928	<i>Hystrix</i>	Hall, 1916
<i>Ovis</i>	Boulenger, 1914	<i>cristata</i>	Storsich, 1896
	Vevers, 1920	<i>Hydroptes</i>	Leiper and Clapham,
	Schwartz, 1925	<i>inermis</i>	1938
	Canavan, 1931	<i>Rupicapra</i>	Gebauer, 1932
	Trofimov, 1940	<i>rupicapra</i>	
	Yamaguti, 1943	<i>Rangifer</i>	Ransom, 1911
	Deo, 1947	<i>tarandus</i>	Winogradowa, 1932
	Zarnowski, 1949		Hellesnes, 1935
<i>Ovibos</i>	Canavan, 1929	<i>Mazama</i>	Ransom, 1911
<i>Capra</i>	Schwartz, 1925	<i>Bison</i>	Locker, 1953
	Bondereva, 1946	<i>Fiber ondatra</i>	Dobrovolski, 1952
<i>Capreolus</i>	Rud, 1819		
	Ambrosioni, 1936		
	Hübner, 1937		

Buckleyuris ezzati sp. n. (Fig. 9)

The species is based on the material consisting of more than 50 specimens (both male and female) collected from a giraffe from the Zoological Gardens, London in 1924. The material was found to be in excellent condition at the time of examination,

Ezzat (1945) described some material under *T. globulosa* bearing perfect resemblance to the species under description. He stated to have found this species in all the cases examined by him from the Giza Zoological Gardens, but he did not find the species in sheep in the Cairo abattoir. It is possible that the species is restricted to only wild animals. The most characteristic part of the species lies in the shape of the vagina and it is clearly borne out from Ezzat's description that he constantly found this character in his material. He stated that "The distal portion of the vagina is short and muscular. Its lumen is lined with large, coarse spines and is thrown into one angular bend. In all specimens examined, only one angular bend was constant." Since he found the species in the following hosts, these hosts are treated as hosts of the new species, *B. ezzati*.

Gazella dorcas, *Gazella dama*, *Gazella leptoceros*, *Gazella rufifrons*, *Ourebia montana*, *Gazella albonotata*, *Giraffe camelopardalis*.

The following description is based on the material from Giraffe from the London Zoological Gardens. All measurements are in millimeters.

Male: Body length 21-25 at the anterior thin portion and 10-12 at the posterior thick portion. The body measured 0.27 thick at about the junction of the anterior and posterior portions and 0.95 thick in the middle of the region of the seminal vesicle. The spicule measured 2.7-3.8 and is thick and lightly cuticularised. It maintains a more or less even thickness throughout its length and tapers rather rapidly, distally, to end in a blunt point. The thickness of the spicule at about the middle is about 0.05-0.065. The spicular sheath consists of a proximal shaft of uniform diameter and a distal globular bulb furnished with a prepuce. The shaft of the spicular sheath is set with spines which decrease in size posteriorly and are closely set, backwardly directed and measuring 0.005 long on the proximal portion of the shaft. The spines on the bulb of the spicular sheath increase in size posteriorly from its junction with the shaft and measuring about 0.01-0.0125 long at about the middle of the bulb. The distal third portion of the sheath is devoid of spines. The shaft of the spicular sheath is rather stumpy measuring 0.25-0.32 long and 0.1 thick. The globular bulb has a diameter of 0.225-0.325. The spines on both the spicular shaft and the bulb are uniformly dense in contrast to *B. globulosa* in which the spines on the bulb are rather sparse.

The testis starts in the region of cloaca and is straight along the ejaculatory duct but closely coiled in the region of the seminal vesicle. The cloaca measured 2-2.3 long, the highly muscular ejaculatory duct 3.8-4.6 long and the seminal vesicle 4.7-5.4 long. The seminal vesicle and ejaculatory ducts are joined by a distinct short sphincter.

Female: Body length measured 22-27 at the anterior thin portion and 12-14 long at the posterior thick portion. The maximum body width is reached in the region of the commencement of the uterus where it measured 0.75-0.82. The portion of the body accommodating the vagina measured 4.5-4.8 long. The vagina is very characteristic showing an angular bend in the distal portion and this feature is constant in all the specimens examined. The angular bend in the distal portion is connected with a large egg chamber. The distal portion is lined with spines while the egg chamber shows longitudinal folds on its inner lining. The lining of the proximal portion of the vagina, preceding the egg chamber, is raised into pupillae. The eggs measure $0.053-0.055 \times 0.0275-0.03$.

DISCUSSION

B. ezzati appears morphologically to be closest to *Buckleyuris globulosa*. It is distinguished from *B. globulosa* in that the spines in the new species show an even density on both the shaft and the bulb of the spicular sheath. In *B. globulosa*, on the other hand, the spines on the distal bulb are less dense than those of proximal shaft. The spicule in the new species is shorter lightly cuticularised and thicker than that of *B. globulosa*. The distal bulb of the sheath in *B. ezzati* measures about double the size of that of *B. globulosa*. An important differentiating feature is the presence of one angular bend in the distal portion of vagina in *B. ezzati*.

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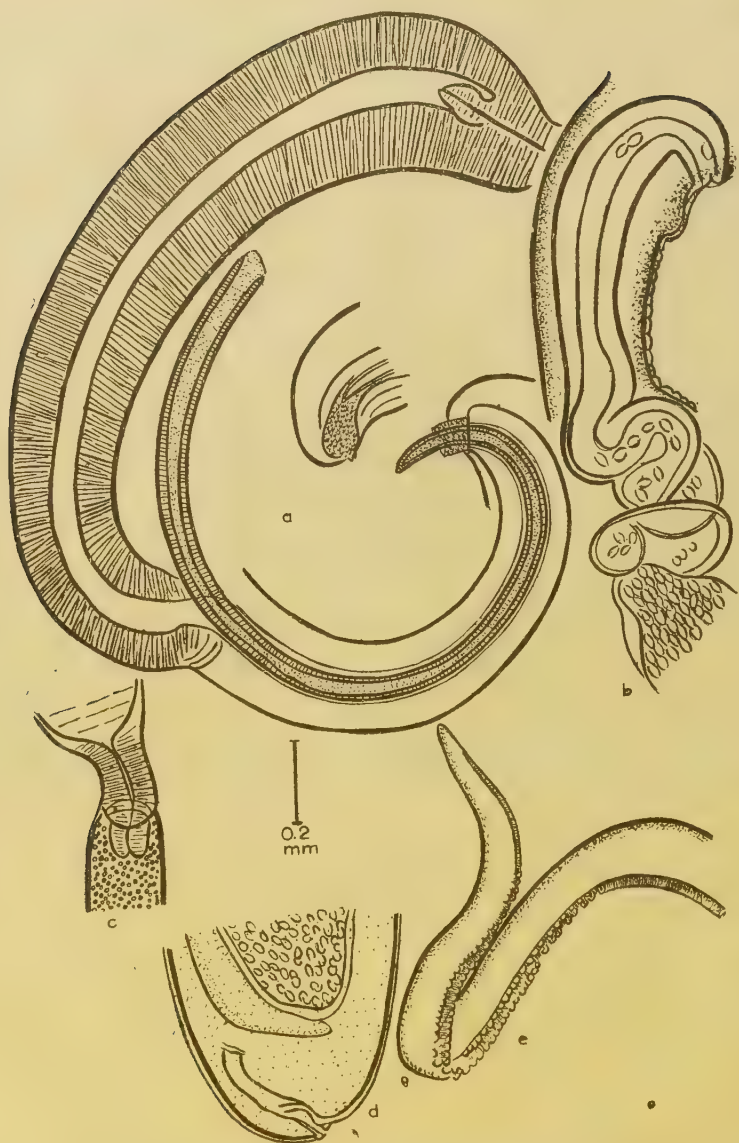


Fig. 1. *T. trichiura*. (a) hind end of male, (b) vagina, (c) junction of seminal vesicle and ejaculatory duct, (d) hind end of female, (e) anterior extremity.

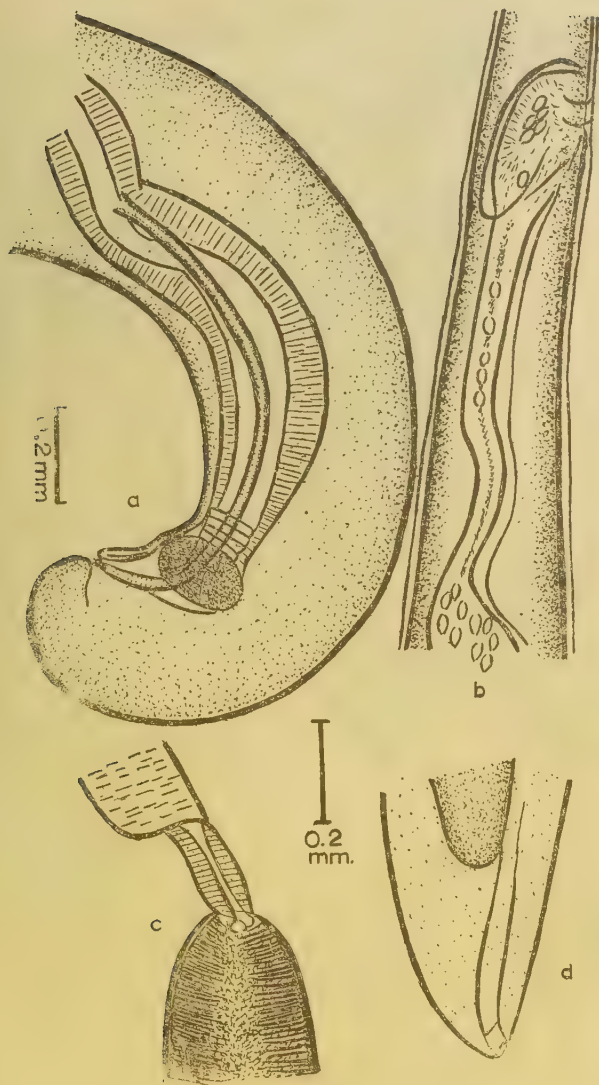


Fig. 2. *T. hystricis*. (a) hind end of male, (b) vagina, (c) junction of seminal vesicle and ejaculatory duct, (d) hind end of female.

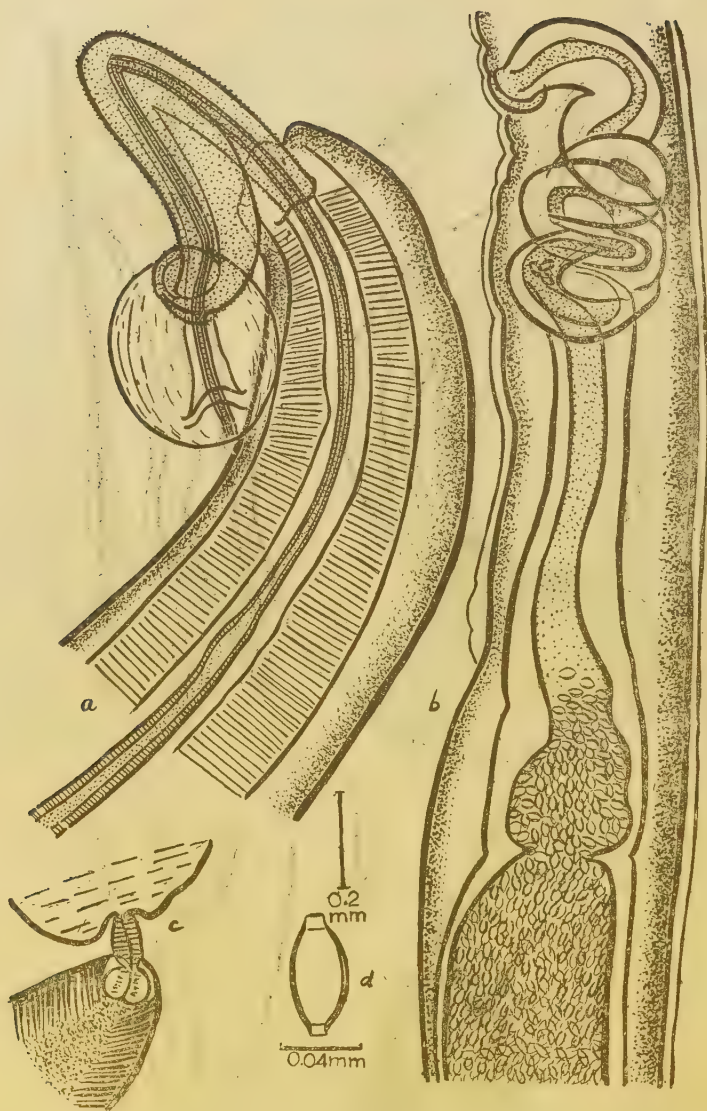


Fig. 3. *T. mettami*. (a) hind end of male, (b) vagina, (c) junction of seminal vesicle and ejaculatory duct, (d) egg.

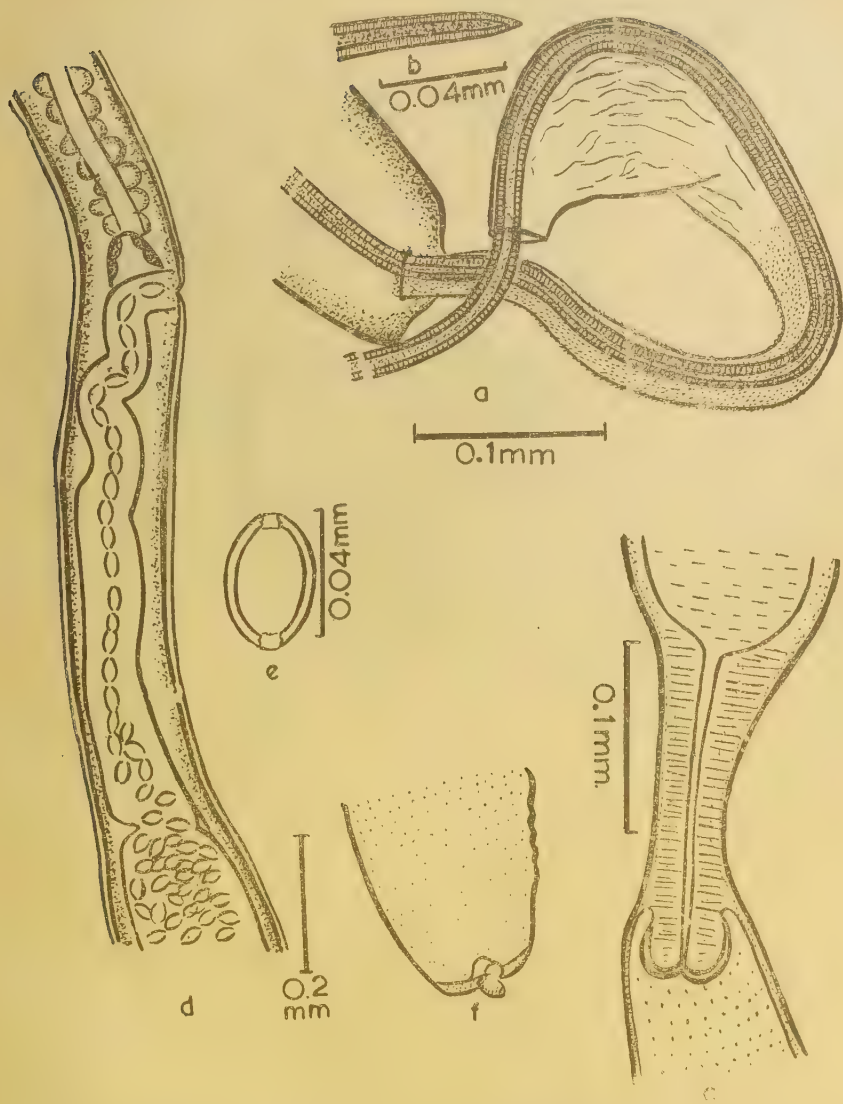


Fig. 4. *T. peramelis*. (a) hind end of male, (b) distal end of spicule, (c) junction of semina vesicle and ejaculatory duct, (d) vagina, (e) egg, (f) hind end of female.

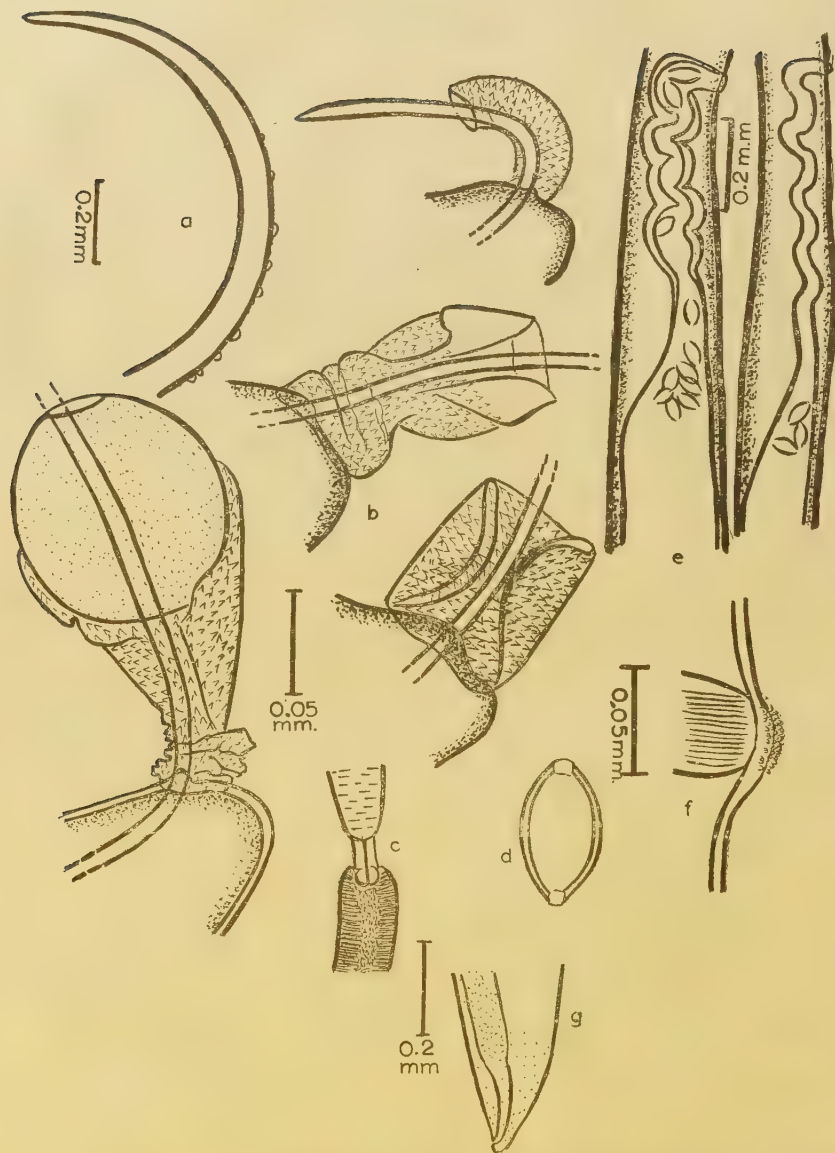


Fig. 5. *T. marsupialis*. (a) anterior extremity, (b) hind end of male, (c) junction of seminal vesicle and ejaculatory duct, (d) egg, (e) vagina, (f) vulva, (g) hind end of female.

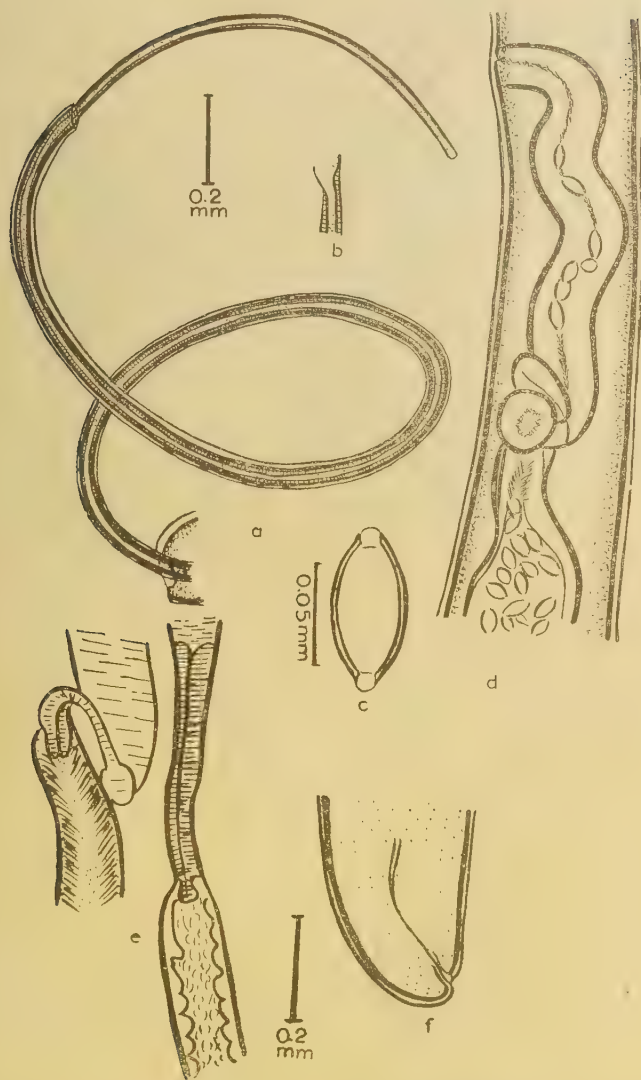


Fig. 6. *R. vulpis*. (a) hind end of male, (b) proximal end of spicule, (c) egg. (d) vagina, (e) junction of seminal vesicle and ejaculatory duct, (f) hind end of female.

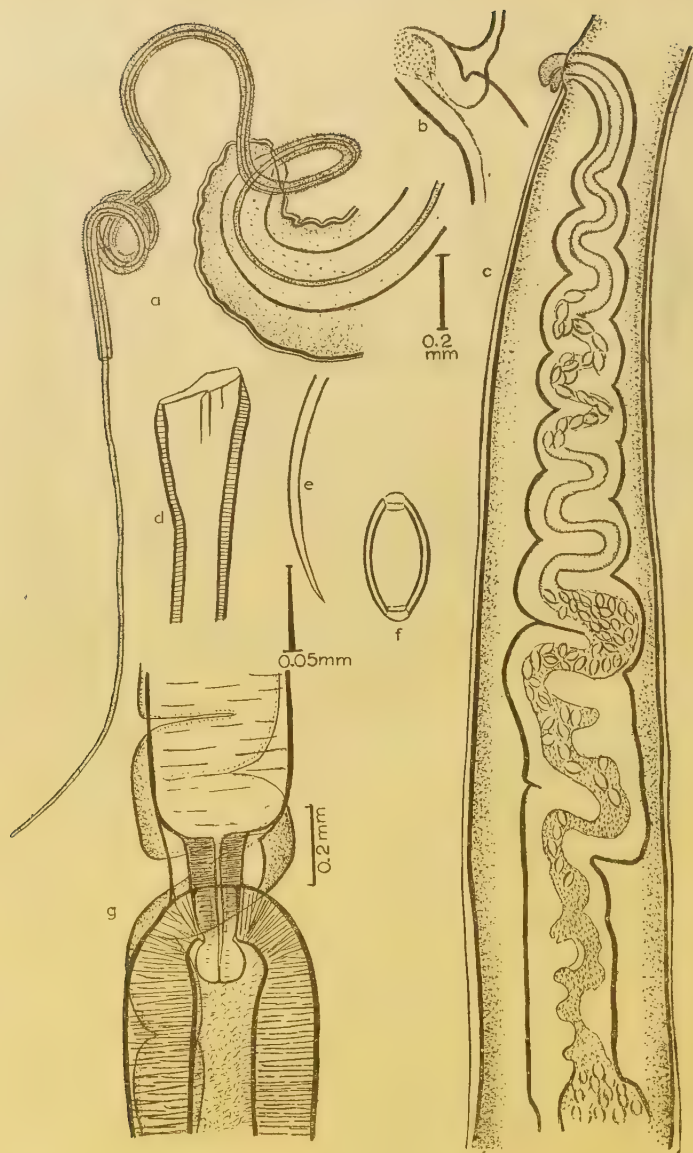


Fig. 7. *B. cervicaprae*. (a) hind end of male, (b) vulva, (c) vagina, (d) proximal end of spicule, (e) distal end of spicule, (f) egg, (g) junction of seminal vesicle and ejaculatory duct.

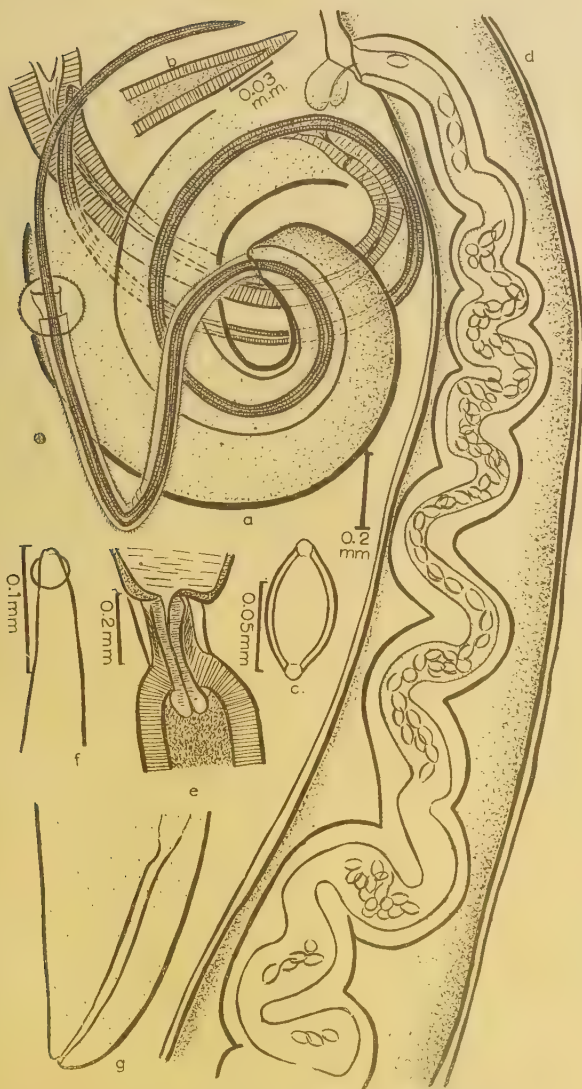


Fig. 8. *B. ovis*. (a) hind end of male, (b) distal end of spicule, (c) egg, (d) vagina, (e) junction of seminal vesicle and ejaculatory duct, (f) anterior extremity.

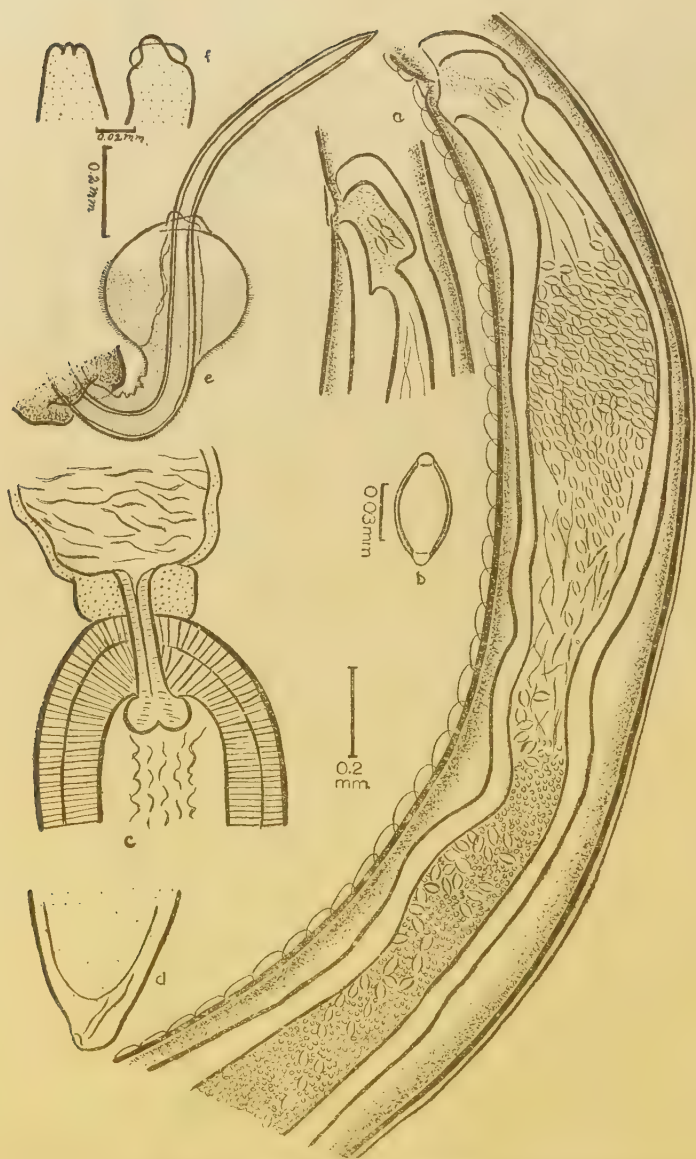


Fig. 9. *B. ezzati*. (a) vagina, (b) egg, (c) junction of seminal vesicle and ejaculatory duct, (d) hind end of female, (e) hind end of male.

Revision of the genus *Atelanthera* Hk. f. et Thom.

S. M. H. JAFRI, M.Sc., Ph.D. (Edin.)

Atelanthera Hook. f. et Thomson, one of the most interesting genera of the family Cruciferae, was described in the year 1861 by Hooker fil. and Thomson (1861). Till 1954 when Jafri (1956) found another species, *A. pentandra*, from Kashmir, it was represented by only one species, *A. perpusilla* Hk. f. et Thom. During the same time Gilli (1955) described a third species from Afghanistan.

W. B. Hemsley suggested that *A. perpusilla* Hk. f. et Thom. was conspecific with *Erysimum sisymbrioides* C.A.M., which is evident from an interesting correspondence (in Herb. Kew) between T. S. Sprague and Arber during the year 1931. Sprague in his reply to a letter from Arber says, "Our only material of *A. perpusilla* is Thomson's original specimen from Zanskar (W. Tibet).....and I find, however, that *A. perpusilla* has been recorded by Korshinsky from Turkestan.....Korshinsky gives a redescription of the species mentioning that the anthers of the long stamens are unilocular..... (.....1898)."

It is interesting to note that the specimen of *A. pentandra* Jafri was already present in the Kew Herbarium when Sprague replied to Arber, but was laid in among the unidentified Crucifers. This specimen was communicated to the Kew Herbarium during 1928 by B. B. Osmaston. Although Osmaston's plants are not in fruit, they could have been easily identified even from the stamen character and the general habit of the plants. (Fig. 1).

However, in the same letter, Sprague gives the distinguishing characters of *A. perpusilla* and *E. sisymbrioides* in the following words:

"*Atelanthera perpusilla* : Anthers apiculate, those of the long stamens monothecous. Siliquae with distinct slender style about 0.8 mm. long.

Erysimum sisymbrioides : Anthers not apiculate, all ditheous. Siliquae without a distinct style."

The above-mentioned characters leave out a most important vegetative diagnostic character which I have not seen mentioned, even in any Flora. The leaves of *Atelanthera* are few (3-5 only) and the first two (not the cotyledons) are opposite or almost so. (Fig. 1) In *Erysimum sisymbrioides* there are no opposite but several alternate leaves. This and the stamen characters of *A. pentandra* Jafri have, therefore, obliged me to give an adequate generic description of *Atelanthera* Hk. f. et Thom.

Specimens collected by Duthie [No. 8571 (Kew)] from Khojak pass, Baluchistan, and published in Burkill's List of flowering plants of Baluchis-

tan (1909) were wrongly identified as *Atelanthera perpusilla*. They are *Erysimum sisymbrioides*. Thus, the only record which I have seen of the *Type species* of the genus is still Thomson's original gathering from Zanskar (W. Tibet). From Korshinsky's description, however, there can be no doubt that his specimens are *A. perpusilla*. Therefore, this species is recorded from W. Tibet and Turkestan only.

The second species, *A. pentandra* Jafri, is from Kashmir, probably from very near the area of the type species of the genus. It can be distinguished from *A. perpusilla* by its five stamens only, and even the outer ones apiculate. Furthermore, the inner longer stamens are only three; of these, two have monotheccous and one ditheccous anthers. (Fig. 1 and 2).

This curious genus of Cruciferae is the only one in which there are some monotheccous anthers. Although the suppression of the two outer stamens [cf. *Cardamine hirsuta* L. or *Lepidium apetalum* Willd. (floral diagram No. I, Fig. 2)], or the four inner stamens [cf. *Coronopus didymus* (L.) Sm.



Fig. 1. *Atelanthera pentandra* Jafri. $\times 3$. Showing the floral parts (specially the stamens) and the first two opposite cauline leaves.

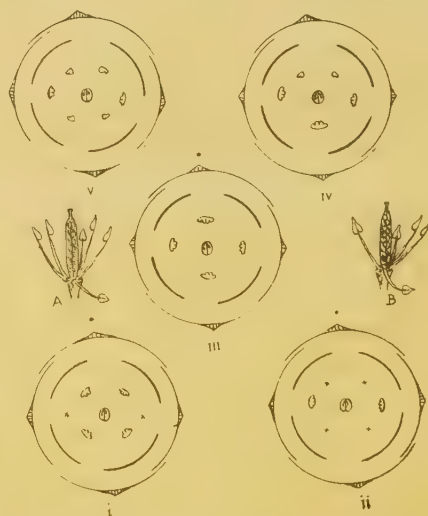


Fig. 2. A, part of the flower showing the stamens of *Atelanthera perpusilla* Hk. f. et Th.—4 inner long stamens monotheccous. B, part of the flower showing the stamens of *A. pentandra* Jafri inner long stamens only 3, dimorphic, one ditheccous and two monotheccous. i—*Cardamine hirsuta* L., ii—*Coronopus didymus* (L.) Sm.; iii—hypothetical; iv—*Atelanthera pentandra* Jafri, v—*A. perpusilla* Hk. f. et Th.

(floral diagram No. II, Fig. 2)] is very well known in Cruciferae, the type of variation and dimorphism of anthers found in *Atelanthera* is confined to this genus. The discovery of the second species, *A. pentandra* Jafri, raises an interesting question: has this genus 6 or 4 as the basic number of stamens, or is it 6 in one species and only 5 in the other? According to the various Floras concerned, the number of stamens mentioned for *Atelanthera* is 6—the usual number present in Cruciferae. But *A. pentandra* Jafri has only 5 stamens: the 2 outer ones are normal as in other members of this family, but the 3 inner are dimorphic—one dithealous and two monothecous (Fig. 1 and 2). In *A. perpusilla* Hk. f. et Thom. (and also in *A. contorta* Gilli) the inner stamens are 4, like most of the other Crucifers, but they are all monothecous. (Fig. 2). It appears, therefore, as though the two monothecous stamens represent a split condition of one dithealous stamen; in that case the basic number of the stamens in the genus would be four only (floral diag. No. II, Fig. 2). Then *A. pentandra* Jafri would have an intermediate position in which only one of the two inner stamens has split into two (floral diag. No. IV, Fig. 2). If the basic number is six, as in *A. perpusilla* (floral diag. No. V, Fig. 2), then *A. pentandra* has got two of the inner stamens fused together giving a dithealous condition, while the other inner two have still remained monothecous. However, the exact nature can be clarified only by further anatomical and developmental studies. In the absence of any such information, I have preferred to describe one species as having 6 stamens and the other 5 stamens, irrespective of the original basic number.

In the absence of fruit, only technical staminal characters have been found to separate *A. pentandra* from *A. perpusilla*. It is possible, however, that further material in future may show that this remarkable floral difference is not a constant character sufficient to justify their distinct specific rank. In the meantime, however, describing *A. pentandra* as separate species attention is drawn to this unique floral condition in the Cruciferae. Furthermore, it also reveals that the generic description given by the previous authors as "4 inner stamens monothecous", is not sufficient. And the presence of dithealous condition in one inner stamen of *A. pentandra* brings *Atelanthera* [which so far stood quite aloof from the other Crucifers by having only monothecous inner stamens] more close to the other Crucifers which all have only dithealous anthers.

We need more gatherings of the plants of this genus to study the range of variations in the already three described species. Specially gatherings from the type locality will prove very useful to show the variations in stamen and fruit characters, on which the two latter species, *A. pentandra* Jafri

and *A. contorta* Gilli, have been separated from the type species, *A. perpusilla* Hk. f. et Thom.

***Atelanthera* Hook. f. et Thom.**

Annuals, minute, erect, slender, simple or very sparsely branched above, somewhat roughly hairy with bipartite-appressed hairs; stem thin or filiform, often violaceous below. Cotyledons often persistent, minute, oblong, sessile, glabrous, entire. Basal leaves absent or represented by cotyledons only. *Cauline leaves few, the first two opposite or almost so, the third and fourth (if present alternate, oblong-elliptic or oblong-cuneate, sessile, entire, covered with bipartite-appressed hairs, apex rounded rarely acute. Racemes 2-5 flowered only, lax. Flowers small, 2-3 mm. across, white, sometimes turning violet; pedicels short, filiform. Sepals 4, short, suberect, equal, oblong, obtuse, hairy, margin white. Petals 4, about twice as long as the sepals, oblong-obovate, apex subemarginate. Stamens 6 or 5 only; outer two short, with ditheous usually subapiculate or blunt anthers; inner alike or dimorphic, apiculate (all 4 with monothecous anthers, or 2 monothecous and one ditheous). Ovary oblong, subcylindrical, 12-24-ovuled; style about 1 mm. long with capitate sub bilobed stigma; Siliquae linear, compressed, subterete, straight or contorted, bilocular, dehiscent; valves hairy with bipartite-appressed hairs, usually with a distinct mid-rib; septum membranous, somewhat rigid, not veined; seeds 1-seriate, oblong, subcompressed, brown. Species three: two in W. Tibet and Kashmir, and one in Afghanistan.*

TYPE SPECIES : *Atelanthera perpusilla* Hk. f. and Thomson—from Zanskar, W. Tibet.

Key to the spp.

1. Stamens 6; inner 4 alike, monothecous.....2
1. Stamens 5; inner 3 dimorphic: 2 monothecous, and 1 ditheous...
.....3. *A. pentandra*
2. Leaves 1-3 mm. broad; siliquae straight, not contorted.....
.....1. *A. perpusilla*
2. Leaves hardly 0.5 mm. broad; siliquae contorted. 2. *A. contorta*
1. ***Atelanthera perpusilla*** Hooker f. et Thomson in Journ. Linn. Soc. Bot., v : 138 (1861); Fl. Brit. Ind., i: 133 (1872) ; Korshinsky in Bull. Acad. Imp. Sc. Petersb., Ser. V, ix: 414 (1898); Schulz in Engler and Prantl Die Naturl. Pflanzenf., 17 b (1936).

Annual, minute herb, 3-5 cm. tall. erect. simple rarely branched above, hairy with bipartite appressed, somewhat rough hairs. Leaves oblong-elliptic or linear, 10-15×1-3 mm., sessile, entire, apex rounded or acute. Racemes 2-5 flowered, lax, ebracteate. Flowers 2-3 mm. across, white or turning violet; pedicels short, hardly 1 mm. long in fruits. Sepals 1.7-2×

0.6-0.75 mm. Petals $3-3.2 \times 0.8-1$ mm. Stamens 6; outer two 2.8-3 mm. long ditheous, apex of the anthers blunt or sub-apiculate; inner four alike, 3.2-3.5 mm. long, monothecous, apiculate. Ovary oblong, about 24-ovuled, hairy. Siliquae about 20×1 mm., linear-oblong, compressed-terete; valves covered with bipartite-appressed hairs, mid-rib distinct; style about 0.8 mm. long with a capitate stigma. seeds 7-10 in each loculus, about 0.7×0.4 mm: septum not veined.

Distribution: W. Tibet, Zanskar, Thomson (Kew ! B. M. !), Turkestan, Alaj valley, by the river Karasu, c. 3000 m., Korshinsky (Leningrad—not seen).

2. *Atelanthera contorta* Gilli in Fedde, Rep. 57 (3) : 225 (1955).

Annual, fruiting stem 5-9 cm. tall, laxly fruiting, usually simple, slender, hairs bipartite, scattered, adpressed, upper fruits rarely bractea e. Leaves narrowly linear, 5-15 mm. long, hardly 0.5 mm. broad, lower sometimes linear-lanceolate, sessile, obtuse, entire, curved, covered densely by bipartite-adpressed hairs. Sepals oblong, obtuse, densely covered by bipartite-adpressed hairs, margin membranous. Petals twice as long as the sepals, 3 mm. long, hardly 0.5 mm. broad, narrow, cuneate, with long slender claw. violaceous when dry, few-veined, apex emarginate. Stamens filiform, anthers of the long stamens unilocular, very acute; anthers of the small stamens bilocular, small, yellowish. Pistil sessile, stalk-like densely covered by bipartite adpressed hairs; style distinct; stigma capitate, broader than the style. Siliquae erect, smooth, contorted, dorsally compressed, 13-25 mm. long, 0.5-0.75 mm. broad; valves densely covered with bipartite-adpressed hairs, median nerve indistinct; septum not veined, epidermal cells parallel; style 0.25-1 mm. long; Valves very narrow; stigma capitate; style not or hardly broadened. Seeds 12-16 in a single silique, dark coloured, ovoid, 1 mm. long, 0.5 mm. broad, granulate, pendulous, markedly uniseriate; funicle small, slender, curved.

Afghanistan: north of Seewaki (south-east of Kabul), between calcareous and powdry soil, 2500 m., 2.6.50, leg. et det. A. Gilli, XCV(Exs. no. 1209) (Type, Vienna; isotype, Khp.)

3. *Atelanthera pentandra* Jafri in Notes Roy. Bot. Gard. Edin., xxii : 102(1956).

Minute annual, 1-2 cm. tall; stems erect, filiform, violet coloured below; hairs bipartite-appressed. Cotyledons persistent, minute, about 2×1 mm., oblong, sessile, fleshy, glabrous, violet coloured. Cauline leaves usually two, opposite, $3-5 \times 0.6-1.2$ mm., oblong elliptic, sessile, pubescent, apex rounded margin entire. Racemes 1-3-flowered, lax. Flowers 2.5 mm. across, white; pedicels 1-1.5 mm., long, filiform. Sepals 2×0.8 mm., oblong suberect,

obtuse, equal, pubescent. Petals 3.5×1 mm., oblong-obovate, emarginate. Ovary oblong, subcylindrical, about 14 ovuled; style about 0.6 mm. long, stigma capitate, sub-bilobed. Siliquae not seen.

Kashmire: Sura, 3090 m., a tiny plant on sand, flowers white, B.B.
Osmaston No. 224, *Type* in Herb. Kew.

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Application of Cytogenetical Methods in Determining a New Species of *Corchorus*

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INTRODUCTION

There are many examples on record in which morphological characters have not been found enough to distinguish closely related species. The research work carried out by Clausen and co-workers (1951) has shown that in such cases the cytogenetical tests are very helpful. They have shown that if genetic barrier exists which hinders the free flow of the genes between the morphologically somewhat similar species, they should be treated as different species. On the basis of cytogenetical studies they split a species of *Holocorpha* into 4. They also transferred a species of *Lavie* viz. *L. nutans* to the genus *Madia*.

The necessity to apply such cytogenetical test arose when the two well-known Herbaria of the world, namely, one at the Kew Gardens and the other at the Indian Botanical Garden, Calcutta, identified a locally collected *Corchorus* specimen (Fig. 5) as two separate species and we ourselves could not assign it to any of the eight previously reported species of *Corchorus* of the Indo-Pakistan sub-continent (Hooker, 1872) because of its morphological differences in important characters with them. The former described it as a species close to *C. trilocularis* L. and the latter identified it as *C. olitorius* L. Because of this discrepancy between the findings of the above two herbaria and because of our suspicion that it may turn out to be a new species, the unidentified specimen was crossed with both *C. olitorius* and *C. trilocularis* in addition to our working out the detailed morphological differences between the three species.

MATERIAL AND METHOD

A.—Material.

A few plants of a *Corchorus* species were collected from a cultivated field near Hala—a place situated about 25 miles north of Hyderabad town, West Pakistan. In addition, the following species of *Corchorus* were used in the investigation:

1. (a) *C. olitorius* L. variety Chinsura Green ex-Dacca.
(b) Do. L. ex-Hyderabad.
2. *C. trilocularis* L. ex-Hyderabad.

B.—*Method.*

The conventional method of crossing was followed. For meiotic studies, temporary slides in aceto-carmin were made, while the root-tips were prefixed in paradichlorobenzene and stained in leucobasic fuchsin. The time of hydrolysis was 15 minutes at 58°C. Squashed root-tip was mounted in a drop of aceto-carmin.

EXPERIMENTAL RESULTS

(a) *Morphological studies*

The specimen was carefully compared with *C. olitorius* and *C. trilocularis* and morphologically it appeared different from both of them. In Table I the characters of the unidentified specimen have been compared with those of *C. olitorius* and *C. trilocularis*.

The leaf of the unidentified specimen as shown in the Table I and (Fig. 1) stands distinct in being oblique and narrower from the leaves of *C. olitorius* and *C. trilocularis* in both of which they are never oblique and always broader. The fruit of the unidentified is very distinct from the fruits of the other 2 species. As against 10-ribbed fruits with slightly toothed apex in *C. olitorius* and triangular hispid fruits in *C. trilocularis*, the fruits in the unidentified specimen are smooth, cylindrical and not provided with any ribs. As the characters of the fruits form the basis of classification in *Corchorus* species, such an important difference in the fruit character between the unidentified and the other two species seemed to us to indicate that the former was a new species.

From the Table I it is further clear that the unidentified specimen differs from *C. olitorius* in respect of (1) number of carpels; the number of carpels in *C. olitorius* varies from 5-6 as against 3, sometimes four in the former (Fig. 4) and (2) surface and length of fruits; the fruits of *olitorius* are always larger, 10-ribbed with their apices slightly toothed while in the former they are always smaller, smooth having no toothed apex and without any ribs.

The unidentified specimen differs from *C. trilocularis*, in respect of (1) plant height; the former grows to a height of 4'—6' as against the maximum height of 3' in *C. trilocularis*, (2) shape of flower bud (Fig. 2); buds in the former are roundish and provided with ridges as against somewhat quadrangular-shaped buds with no ridges in *C. trilocularis*, (3) fruit shape (Fig. 3); in the former the fruits are cylindrical while in the latter the fruits are slender, triangular and hispid.

(b) *Crossing Relationship*

Our next line of approach was to see the cross compatibility of the unidentified specimen with *C. olitorius* and *C. trilocularis*. Successful crosses

TABLE I
Comparison of Morphological Characters between *C. olitorius*, *trilobularis* and Unidentified Specimen

Character	<i>C. olitorius</i> (a)	<i>C. trilobularis</i> (b)	Unidentified species (c)
1. General			
(a) Height.	Cultivated type: 8-10' tall; wild; below 3'. Smooth.	Never more than 3'. Hispid.	4-6' tall. Smooth.
(b) Surface of the stem.			
2. Leaf			
(a) Shape.	Ovate, lanceolate, never oblique.	Mostly oblong, never oblique.	Not oblong, leaves slightly oblique.
(b) Apex.	Always acute.	Mostly obtuse, sometimes acute	Always acute.
(c) Margin.	Serrate.	Dentate.	Serrate with narrower teeth.
3. Flower bud			
(a) Shape.	Roundish.	More or less quadrangular.	Roundish, always smaller in size than the buds of (a) and (b).
(b) Apex.	Less pointed.	Pointed and tapering.	Less pointed.
(c) Surface.	Ridges present.	No ridge.	Ridges more pronounced than in (a).
4. Flower			
(a) Size.	Larger than in (b) and (c).	Smaller than (a).	Same as in (b).
(b) No. of carpels.	5-6 mostly 6.	Always 3.	Mostly 3, sometimes 4.
5. Fruit			
(a) Apex.	Slightly toothed.	Smooth.	Smooth.
(b) Shape.	Cylindrical.	Triangular.	Cylindrical.
(c) Size.	5-7.5 cms. long, greater width than the other two.	5-7.5 cms. slender than (a) and (c).	Never more than 4.5 cm. long, slenderer than (a).
(d) Surface.	10-ribbed.	Rough, hispid without any ridge.	Smooth without any ridge.
(e) No. of fruits at each node.	One to two rarely 3.	Two to three.	Two to three rarely one.
Seeds			
(a) Shape.	Wedge-shaped.	Trigonous triconcave.	Wedge-shaped.
(b) Weight per 100 seeds (seed index).	0.163	0.03	0.08 gms.

NOTE.—Out of 17 characters compared, the unidentified specimen resembled *C. olitorius* in 8 characters, *C. trilobularis* in 4 characters, while 5 characters behaved independently.

followed by the production of fertile hybrids would mean that the specimen in question would either merge with *C. olitorius* or *C. trilocularis* with which it would form fertile hybrids. Restricted exchange of genes would, on the other hand, make it a distinct species.

Accordingly the unidentified specimen which was found to be diploid with $2n=14$ (Fig. 6) was reciprocally crossed with both *C. olitorius* (ex-Dacca and ex-local) and *C. trilocularis* (ex-local). The results of crosses are given below:

TABLE II
Results of Crosses

Parents	No. of crosses	No. of fruit harvested	Percentage of fruit set	No. of seeds per fruit	Percentage of germination	No. of adult plants obtained
1. (a) <i>C. olitorius</i> ex-Dacca × unidentified ...	125	18	14.4	39.3	5.9	Nil
(b) Reciprocal ...	88	8	9.0	49.3	2.1	Nil
2. (a) <i>C. olitorius</i> ex-local × unidentified ...	110	20	18.2	34.2	8.0	2
(b) Reciprocal ...	120	23	19.2	53.6	3.0	2
Total ...	443	69	15.5	—	—	4
3. (a) <i>C. trilocularis</i> × unidentified ...	71	15	21.1	56.3	—	—
(b) Reciprocal ...	21	5	23.8	—	—	—
Total ...	92	20	21.7	—	—	—

UNIDENTIFIED × *C. OLITORIUS*

Out of 443 reciprocal crosses, the fruit set was 18.2 and 14.4 per cent in which local and C.G. races of *C. olitorius* were used respectively as the female parent and 19.2 and 9.1 in the reciprocal cross. The number of seeds in the fruits resulting from crosses were found to be much smaller compared to a large number of seeds in the parent species. The majority of seeds in the crosses in which the unidentified was used as the male parent, were shrunken while in the other direction most of the seeds appeared to be full and viable, but these on dissection were found to be empty. The percentage of germination in both the directions as shown in the Table II was low. Of the few plants which germinated, the majority died between 10—12 days to two months from the date of germination.

The total number of the hybrids as shown in Table II which have grown to maturity were only four, two in the cross *C. olitorius* × unidentified and two in the reciprocal direction. The rate of growth was slow in the hybrids (Fig. 7).

The meiosis of the hybrids was studied from pollen mother cells. Meiotic irregularities which included as many as four lagging chromosomes were seen (Fig. 8). Of the three hybrids which grew to maturity, in the two, flowers dropped before they fully opened and in the third hybrid between the unidentified $\times$ *C. olitorius* ex-local defective small fruits were formed with the undeveloped seeds. Whether these would germinate to give rise to F_2 generation cannot be said at this stage.

UNIDENTIFIED $\times$ *C. TRILOCULARIS*

In all, 92 reciprocal crosses were made between the unidentified and *C. trilocularis*. The percentage of fruit set was 21.1 in which the *C. trilocularis* was used as the female parent while in the reciprocal direction the percentage was 23.8.

The number of seeds obtained per fruit was found to be less than the parent species. Although the percentage of germination of seeds obtained from the crosses was fairly high, none of the seedlings grew to maturity. It was felt, however, that with special care it might be possible in future to obtain F_1 hybrids.

DISCUSSION

Both on morphological as well as on genetical grounds the unidentified specimen stood out as a different species from *C. olitorius*. If the morphological differences between *C. olitorius* and the unidentified were of the nature that distinguish races or subspecies of the same species, there should have been unrestricted flow of genes between them, but this was not so.* Both fruit set and the percentage of germination of seeds obtained therein were low and of the 4 plants, two produced defective fruits with undeveloped seeds and the other two did not produce any fruits, their flowers shedding before they were fully open. The unidentified specimen and *C. olitorius* were found so different genetically that the two could be assigned to two different cenospecies or species complexes in the terminology of Clausen (1951).

The unidentified specimen as has shown in Table I was found to differ from *C. trilocularis* in important morphological characters e.g., leaf shape, shape and surface of flower bud and characters of fruits. In the number of carpels, however, the unidentified specimen appeared to be closer to *C. trilocularis* as both these were found to contain 3 carpels against 5-6 in *C. olitorius*. When

*A few cases are on record in which the failure of crosses is seen even among the different populations of the same species as exemplified by *Datura* species (Blakeslee, Bergner and Avery, 1937). This failure results from continual structural changes taking place in their chromosome but meiotic studies on *Cochorus* species (Banerjee, 1932; Dutta, 1958) suggest that such possibility does not exist in this genus.

genetically tested these morphological differences appeared to be more than what could exist had they belonged to the same species. The question whether the unidentified specimen should be treated as conspecific with *C. trilocularis* or considered to belong to a separate cenospecies different from *C. trilocularis* should remain open until we obtain some F_1 hybrids between them and study their fertility.

Thus the morphological differences and the genetical tests clearly indicate that the specimen is a new species of *Corchorus* and cannot be regarded as either *C. olitorius* or *C. trilocularis* as identified by the Indian Botanic Garden and the Kew Gardens, respectively. It was therefore named as *C. pseudo-olitorius* because of its somewhat close morphological resemblances to *olitorius*. The latin description of the new species is given below:—

***Corchorus pseudo-olitorius* Islam and Zaid, sp. nov.**

Affinis *C. olitorio* L. et *C. triloculari* L., a primo carpellis paucioribus (3-5 nec 5-6), ab altero planta tota glabra caule multo altiore, ab utroque foliis obliquis capsulis brevioribus cylindricis nec sulcatis (*C. olitorius*) nec triangularibus (*C. trilocularis*) differt.

Herba annua caule glabro divaricatim ramosissimo 150-180 cm alta. *Folia* simplicia, alternata, glabra, stipulis liberis linearibus petiolo brevioribus; petiolis 7-13 mm. $\times$ mm., dorso paulo sulcatis; laminis obliquis 3-5 costatis, serratis acutis, serraturis binis infimis 5-7 mm. longis, setaceis caudatis. *Cymae* extra-axillares 2-3 viz. 1-florae. Flores pedicellati, ebracteati, regulares, hermaphroditi. Sepala 5, connata, apicibus rufulis virentia. Petala 5, libera, imbricata, spatulata, flava. *Stamina* c. 20, viz., plura, filamentis c. 2-3 mm. longis, supra torum brevem liberis, antheris globosis, extrosis. Carpella 3 viz. 4, connata, *Ovarium* lineare oblongum. Stylus brevis. *Stigma* capitata (nec lobulata). Capsulae 45 mm. $\times$ 8-10 mm., cylindricae, glabrae, apicibus-capitatis (nec dentatis), in fasciculos 2-3 viz. 1-capsulares dispositae, 3-4 valvatae, dehiscentes. *Semina* cuneata, glabra, septis separata.

Holotype: The type specimen (1068) was collected near Hala, 25 miles north from the Hyderabad town on 22nd August 1957 by Babu Haig, the Plant Collector, Sind University and has been preserved in the Sind University herbarium. The duplicates of the specimen have been sent to the Indian Botanical Gardens Calcutta, the Kew Gardens, England and Dr. R. R. Stewart, Gordon College, Rawalpindi, Pakistan, etc.

In view of the addition of this new species of *Corchorus*, the key of Chakravarty (1951) for Indo-Pakistan species need to be enlarged and modified. The key with the necessary changes is therefore as follows :

KEY TO THE SPECIES (ENLARGED AND ADAPTED FROM CHAKRAVARTY 1951).

A. Capsule globose; beak absent.....*C. capsularis* L. (1)

AA. Capsule elongate; beak present.

B. Beak entire or slightly toothed.

C. Capsules usually 3.0 to 7 cms.

D. Capsule glabrous, plants tall usually 4 to 5 ft.

E. 10-ribbed, one to two at one node, 5-7.5 cm. long usually 5
valved beak slightly toothed.....*C. olitorius* L. (2).EE. Smooth without ribs, never more than 4.5 cms. long. Fruits in
clusters of 2 to 3, three valved occasionally four, beak entire,
leaf slightly oblique *C. pseudo-olitorius* Islam and Zaid
sp. nov. (3).DD. Capsule hispid, slender and scabrous, 4 to 7 cms. long 3-angled,
plant never more than 3 ft.....*C. trilocularis* L. (4).

CC. Capsule never more than 3 cms. in length.

D. Capsule hairy, plant herbaceous, leaves ovate, lanceolate, petiole
shorter than blade.E. Capsule curved, 2 to 3 cms. long, solitary, not in fascicles,
blade *Urtica* like in dentation, fruit hanging downward.....
C. urticaefolius W. and A. (5).EE. Capsule straight 1 to 1.5 cms. long, arranged in fascicles of
2 to 5.....*C. fascicularis* Lam. (6).DD. Capsule glabrous, 1 to 1.5 cms. mostly curved, perennial,
prostrate, leaves small, petiole longer or equal to the blade.....
C. depressus C. Christensen (= *C. antichorus* Raeusch) (7).

BB. Beak 3 fid spreading radially.

C. Capsule not winged, 3 to 4 cms. long, 1.5 cms. in diameter, leaves
narrow, 5 to 7 cms. long, 5-14 cms. broad...*C. tridens* L. (8).CC. Capsule wingedly angular, 3 cms. long, 4 mm. in diameter, leaves
broadly ovate, 7 to 11 cms. long, 3 to 5 cms. broad...*C. aestuans*
L. (= *C. acutangulus* Lam.) (9).

SUMMARY

A locally collected specimen of *Corchorus* could not be assigned to any of the previously reported Indo-Pakistan species of *Corchorus* and when referred to the two well-known herbaria of the world namely, Indian Botanical Gardens and Kew Gardens, London, it was identified as *C. olitorius* and *C. trilocularis* respectively. In order to determine its systematic position, i.e., whether to treat it as a separate species or the same species as *C. olitorius* or *C. trilocularis*, cytogenetic tests were applied.

Its low crossability both with *C. olitorius* and *C. trilocularis* indicated it was a distinct species. It was named *pseudo-olitorius* because of its somewhat close resemblance with *C. olitorius*.

ACKNOWLEDGEMENT

Our sincerest thanks are due to Dr. D. Chatterjee, Director, Indian Botanical Gardens, Calcutta, Dr. Taylor, Director, Royal Botanical Gardens, Kew, England, Dr. R. R. Stewart, Dr. I. I. Chaudhri, for the keen interest they showed in the identification of the species. We also owe gratitude to Dr. Sultan Ahmed for his suggesting a suitable name for the species and to Dr. M. Hossain, Dacca, for his rendering the description of the species into Latin. Our thanks are also due to Mr. E. H. Naqvi for making the diagrams.

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POSTSCRIPT

Since sending this article for publication an abstract entitled 'Study of species relationship of a few species of *Corchorus*' by Dr. A. M. Eunus and Laila Kabir appeared in the Proc. XII Pakistan Science Conference, 1960 (Agric. Section). This paper was neither read in the Science Conference nor the abstract was accompanied by a detailed paper. It is, therefore, not known to us on what basis the authors concluded that *pseudo-olitorius* Islam and Zaid and *trilocularis* L. were synonymous.

There is no doubt that there is a close resemblance between the new species and *C. trilocularis* in their morphological characters and, in fact, the herbarium at the Kew Gardens identified it as a species close to *C. trilocularis*.

It is only after consulting the well-known systematic Botanists of the country, namely, Drs. R. R. Stewart, Sultan Ahmed, S. M. Jafri, etc. and through, our cytogenetical and detailed morphological studies that we have established the plant specimen in question as a new species.

It should have been appreciated if the authors contacted us, particularly when we supplied the seeds to them before they hurried to publish the abstract to invalidate our findings without assigning any reason, *et cetera*.

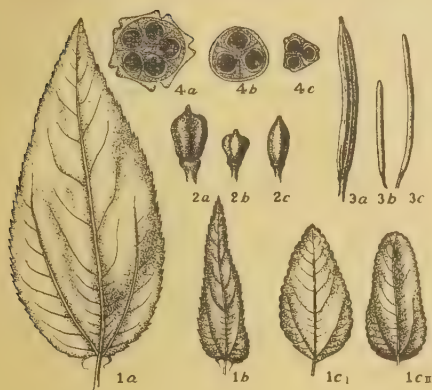


FIG. 6

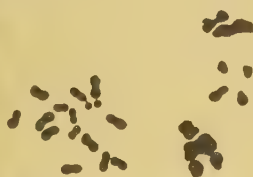


FIG. 8



FIG. 5

- Fig. 1. Leaf shape and size in (a) *C. olitorius*, (b) *C. pseudo-olitorius* and (c₁ & c₁₁) *C. trilocularis*. Note that the leaf shape and apex in *trilocularis* may be different. $\times$ Nat. size.
- Fig. 2. Shape and size of flower bud in (a) *C. olitorius*, (b) *C. pseudo-olitorius* and (c) *C. trilocularis*. $\times 3$.
- Fig. 3. (a) 10-ribbed fruit of *C. olitorius* with slightly toothed apex, (b) smooth and cylindrical fruit of *C. pseudo-olitorius*, and (c) triangular and slender fruit in *C. trilocularis*. $\times$ Nat. size.
- Fig. 4. T. S. through ovary (a) *C. olitorius* showing 5 chambered, (b) *C. pseudo-olitorius* and (c) *C. trilocularis* each showing 3 chambered ovary. Note the ribbed and triangular outline of ovary in *olitorius* and *trilocularis* respectively. $\times 10$.
- Fig. 5. Portion of stem with flowers (A). $\times 2/3$, flower bud (B). $\times 5$, open flower (C). $\times 5$, capsule (D). $\times$ Nat. size capsule dehiscing into 3 valves with seeds having fallen out (E). $\times$ Nat. size, T. S. of ovary showing 3 chambers (F) $\times 10$.
- Fig. 6. Somatic chromosomes from the root-tip of *pseudo-olitorius* with $2n=14$. Note the two satellited chromosomes $\times 2500$ appox.
- Fig. 7. The sterile F₁ hybrid between *C. olitorius* and *C. pseudo-olitorius*. $\times 1/25$ appox.
- Fig. 8. Meiosis of hybrid *olitorius* $\times$ *pseudo-olitorius*; Anaphase I showing 4 lagging chromosomes $\times 2500$ appox.

Some Species of *Cercospora* from West Pakistan

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The genus *Cercospora* is fairly well represented in Pakistan. Ahmad (1956) listed 29 species of the genus occurring on 31 host plants in West Pakistan. Another species of the genus on *Daucus carota* has recently been reported by Nawaz and Khan (1959). The present paper reports three more species of *Cercospora* occurring on *Dodonaea viscosa* L., *Glycyrrhiza glabra* L., and *Momordica charantia* L., respectively, which have not so far been reported in West Pakistan.

The morphological characters of the three species of *Cercospora* occurring on *Dodonaea viscosa* L., *Glycyrrhiza glabra* L. and *Momordica charantia* L. conformed closely to the description of *Cercospora mitteriana* Sydow, *C. cavariae* P. and D. Sacc. and *C. citrullina* Cooke respectively as given by Chupp (1953), except in minor differences in spore septation and the size of conidia and conidiophores. A comparison of the size of the conidia and conidiophores and septation of the conidia of the species being reported and those recorded by Chupp (1953) is presented in Table I.

TABLE I

Size of the conidia and conidiophores of three species of Cercospora

Species		Dimension of conidia and conidiophores	Dimension of conidia and conidiophores as given by Chupp (1953)
<i>C. cavariae</i>	...	Conidia : $3.5-6 \times 40-152\mu$ 1-8 septate. Conidiophores : $3-6 \times 6-60\mu$.	$4-6 \times 30-110\mu$ 1-6 septate. $3-5 \times 5-40\mu$.
<i>C. citrullina</i>	...	Conidia : $3-4 \times 60-400\mu$ multiseptate. Conidiophores : $4-4.5 \times 50-178\mu$.	$2-4 \times 50-220\mu$ even $5.5 \times 450\mu$ multiseptate $4-5.5 \times 50-300\mu$ rarely $6.5 \times 500\mu$.
<i>C. mitteriana</i>	...	Conidia : $3-4 \times 20-81.4\mu$ 1-7 septate. Conidiophores : $3-4 \times 5-30\mu$.	$2.5-4 \times 25-90\mu$ 1-7 septate. $2-4 \times 5-30\mu$.

The description of three species of *Cercospora* on their respective hosts in West Pakistan is given below:

1. *Cercospora cavariae* P. and D. Saccardo.

No definite leaf spots on upper surface of leaves, black sooty effuse fruiting on lower surface, stromata small, fascicles mostly dense; conidiophores pale to olivaceous brown, irregular in width, rarely septate, not branched, spore scar present, $3.6 \times 6.60 \mu$; conidia sub-hyaline to pale, cylindric or slightly attenuated, straight to mildly curved, 1-8 septate, base conically truncate, tip obtuse, $3.5-6.0 \times 40-152 \mu$.

On leaves of *Glycyrrhiza glabra* L., Lyallpur.

2. *Cercospora citrullina* Cooke.

Leaf spots circular to irregular, 0.5-7 mm. in diameter, cream to pale brown in colour; fruiting epiphyllous; stromata none; conidiophores rarely single, usually in fascicles of 2-10, light to pale brown, uniform in width, very rarely slightly attenuated and swollen at some points, almost straight to slightly curved, geniculations in some present, sparingly septate up to five septa, not branched, spore scar conspicuous, $4.4.5 \times 50-178 \mu$; conidia hyaline, acicular, straight to curved, multiseptate, base truncate, tip acute, $3.4 \times 60-400 \mu$.

On leaves of *Momordica charantia* L., Lyallpur.

3. *Cercospora mitteriana* Sydow.

Leaf spots angular to irregular, limited to veins and mostly along the leaf margin, large, pale-brown to tan; fruiting hypophyllous, stroma brownish, fascicles dense; conidiophores olivaceous brown, attenuated or nearly uniform in width, not septate, spore scar present, geniculations rarely present; $3.4 \times 5.30 \mu$; conidia obclavate, subhyaline to olivaceous, straight to slightly curved, 1-7 septate, $3.4 \times 20.0-81.4 \mu$.

On leaves of *Dodonaea viscosa* L., Lyallpur.

According to Chupp (1953), *Cercospora mitteriana* Sydow has been collected and known only on *Dodonaea viscosa* from the type locality, Jullundur, East Punjab, India. The present collection of the fungus from the same host from Lyallpur appears to be the only other collection made after the first collection from a place other than the type locality. However, the species of *Cercospora* occurring on *Momordica charantia* had already been recorded by Butler and Bisby (1931) under the name *Cercospora momordica* McRae (1929) based on

a collection from Pusa, India. *Cercospora momordica* McRae has now been considered a synonym of *Cercospora citrullina* Cooke (Chupp, 1953). This species was also collected by one of the authors from Malir, Karachi in 1957, where it was causing a severe leafspot on the host plant. *Cercospora cavariae* has so far been collected from Sardinia, Turkestan, Asetrakhan and Middle Asia and does not appear to have been recorded from Pakistan.

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Effect of Small Doses of Phenothiazine on the Development of Larvae of *Dictyocaulus Filaria* in Sheep

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Shorb and Habermann (1940)* determined the effectiveness of Phenothiazine in preventing the development of ova of gastro-intestinal nematodes of sheep, when the drug was given in daily doses of $\frac{1}{2}$ g. The nematodes taken into account by the authors belonged to the species *Haemonchus contortus*, *Ostertagia* spp., *Trichostrongylus* spp., *Cooperia* spp., *Bunostomum trigonocephalum*, *Chabertia ovina* and *Strongyloides*. These authors found that the daily administration of $\frac{1}{2}$ g. of phenothiazine completely checked the development of ova of all these parasites, except *Strongyloides* which showed a reduction in their larval counts in the cultures. The authors also found that if the drug was given in 0.25 g. doses, the number of larvae developing was greatly reduced but a complete check could not be attained. Since the publication of these findings, the feeding of Phenothiazine in small doses, has gained a wide approval. But the effectiveness of the measure has not so far been tested on the nematodes infesting organs other than the gastro-intestinal tract. Since, however, the lungworm larvae pass through the gastro-intestinal tract, it would be expected that the larvae are directly exposed to the action of the drug.

METHOD AND MATERIAL

Two artificially infected male lambs Nos. 37 and 75 weighing 52 and 36 lbs., respectively, were employed for the test. Cloth bags were tied around the rectum and faecal pellets were collected twice daily during 8.00-14.00 hours. Out of the two lots of faeces thus collected from each lamb, as many as 100 pellets were taken out from each lot and mixed for culture. All the culture jars were kept in a row under room conditions. Another 10 pellets were taken from each lot for the estimation of the larvae as passed out in the faeces and the average of the two counts taken into account in the accompanying tables. Baermann technique was employed for the estimation of the number of larvae as passed out in the faeces. The pellets were, in each case, soaked for 3-4 hours before 'baermannizing.'

* *Veterinary Medicine*, 35 (7) : 454-457.

Each of the cultures were at the end of the test, flooded with 100 cc. of water, and the walls of the jars washed with the same water, with the help of a camel-hair brush. The washings from each of the culture jars containing the larvae, were poured out after soaking the faecal mass for about $\frac{1}{2}$ hour. In the process of pouring, the faecal mass was kept in check with the help of a glass slide held at the mouth of the jar. For the estimation of infective larvae, the washings from each jar were thoroughly stirred and a 1 c. c. sample drawn out. Three readings from each washing were recorded, before calculating the number of larvae present. Phenothiazine was administered by mouth every morning with the help of a test tube after mixing it with water. The mixture was poured out at the back of the tongue and care was taken to see that the full quantity was invariably administered.

Experiment I

The results are tabulated in Table I. As may appear from the table, there is a marked reduction in the larval count in faeces collected between 24 and 30 hours after the first administration of the drug. The faeces

Table I

RESULT OF DAILY ADMINISTRATION OF PHENOTHIAZINE AT THE RATE OF $\frac{1}{2}$ G. ON LARVAE OF *DICTYOCAULUS FILARIA* IN A LAMB (No. 37)

Date		Details of Procedure				Result of Examination	
		Quantity and time of administration of the drug	Total number of pellets collected between 8.00 and 14.00	Number of pellets used in cultures	Number of larvae estimated as passed out per 10 pellets	Date of Examination of culture	Number of larvae collected from washings of the jar
19-2-59	...	$\frac{1}{2}$ g. (9.00)	650	200	128	5-3-59	1125
20-2-59	...	do.	609	200	172	5-3-59	160
21-2-59	...	do.	678	200	165	5-3-59	nil
22-2-59	...	do.	NO OBSERVATIONS RECORDED				
23-2-59	...	do.	642	200	72	5-3-59	nil
24-2-59	...	Not administered	808	200	125	5-3-59	nil
25-2-59	...	do.	867	200	72	5-3-59	931

collected from 48 hours after the first administration, did not yield any infective larvae on culture. Again, larvae reappeared in cultures on the second day after the administration of the last dose.

Experiment II

The results are tabulated in Table II. As the larval count was on the increase during the first few days of the experiment, it would not be fit to suggest a comparison between the first two days observations but a clear cut comparison is possible for the period at the termination of the experiment.

Table II

RESULT OF DAILY ADMINISTRATION OF PHENOTHAIAZINE AT THE RATE OF $\frac{1}{4}$ G. ON LARVAE OF *DICTYOCAULUS FILARIA* IN A LAMB (No. 75)

Date	Details of Procedure				Result of Examination	
	Quantity and time of administration of the drug	Total number of pellets collected between 8.00 and 14.00	Number of pellets used in cultures	Number of larvae estimated as passed out per 10 pellets	Date of examination of culture	Number of larvae collected from the washings of the jar
13-3-59	... $\frac{1}{4}$ g. (8.00)	215	200	59	31-3-59	160
14-3-59	... do.	321	200	74	31-3-59	189
15-3-59	... do.	NO OBSERVATIONS RECORDED				
16-3-59	... do.	328	200	196	31-3-59	120
17-3-59	... do.	446	200	154	31-3-59	435
18-3-59	... do.	586	200	162	31-3-59	152
19-3-59	... Not administered	558	200	148	31-3-59	164
20-3-59	... do.	500	200	117	1-4-59	285
24-3-59	... do.	531	200	121	1-4-59	1440

Again, as the daily larval counts in the two lambs are identical, it would appear reasonable to compare the counts detailed in Exp. II with the counts at the beginning in Exp. I. Quite evidently, there is a noticeable reduction in larval counts after feeding of phenothiazine at the rate of 0.25 g. daily.

In the above two experiments, the larvae passed out in faeces were always found to be perfectly normal—looking but in another batch of five sheep which were passing out variable number of larvae, there were signs of degeneration already evident in many of the larvae at the time they were passed out. All the five sheep were being fed phenothiazine at the rate of 1 g. daily.

SUMMARY

Feeding of phenothiazine at the rate of 0.5 g. daily, prevented the development of *Dictyocaulus filaria* larvae in the faeces of sheep. When the drug was given at the rate of 0.25 g. daily, there was observed to be a marked reduction in the number of larvae recovered from the cultures.

While the larvae from sheep fed phenothiazine at the rate of 0.5 and 0.25 g. daily, were normal looking when passed out, there were signs of degeneration in the larvae from sheep fed with a daily dose of the drug at the rate of 1 g.

Additions and Corrections to the Genus *Silene* L. in West Pakistan and N. W. Himalayas

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Since the publication of my paper on the genus *Silene* L. in West Pakistan and N. W. Himalayas in the June 1959 issue of *Biologia* I have had the chance of examining more specimens in the herbaria at Kew, the British Natural History Museum and the Royal Botanic Gardens, Edinburgh and have found it necessary to make the following corrections and additions.

A *Silene* flower has usually three styles and the carpels are opposite the calyx segments. The capsule dehisces by twice as many teeth as there are styles.

On page 65, number 3 should be *Silene brahuica* Boiss instead of *Silene aucheriana*. The synonyms mentioned are for *Silene aucheriana* which is also reported from Baluchistan and has a number of stems from the base and a large number of lanceolate basal leaves. The cauline leaves are lanceolate and opposite. They are not in whorls as in *S. brahuica*. The flowers are both axillary and terminal.

Page 66, number 7. The name *Silene viscosa* (L) Pers. is to be used. *Silene griffithii* hence becomes a synonym.

Page 68, number 8. *Silene latifolius* (Mills) Rendle and Britt. is to be used instead of *Silene inflata* Sm. which becomes a synonym. *Cucubalus behen* L. is not a synonym of this species.

Page 70, number 13. *Silene amoena* L. is not a synonym of *S. tenuis* Willd.

I have also examined the following species which are not mentioned in my previous paper.

1. *Silene coniflora* Otth. 4 to 6 inches tall, unbranched; leaves narrowly lanceolate, about one inch long. One terminal flower; corolla pink.

Distribution. Khyber Pass.

2. *Silene schaffia* Gmel. Plants perennial, 30 cm tall, a number of branches from the base; stems slender, pubescent; leaves shortly lanceolate to obovate, apex acute. Flowers mostly terminal; calyx oblong to clavate; petals rosy, bipartite, lobes large and bifid, two auricles and two scales; the carpophore as long as the ovary. *Jutial Nala, Gligit, Stewart 26266.*

3. *Silene afghanica* Rohrb. Stem erect, simple, glabrous, upper viscous. Leaves linear. Bracts ovate, lanceolate, white margined, ciliate. Calyx as long as the pedicels, tubular, teeth ovate lanceolate, obtuse, ciliate. Petals bipartite, lobes oblong to linear, appendages two, obtuse.

Chitral, 3600 m, 18-7-1950, *Wendelbo* (K)

4. *Silene colorata* Poir.

S. bipartita Desf.

A small plant. Leaves spatulate, about 4 cm long. Inflorescence a monochasial cyme. Flowers 2 cm long.

Salt Range, *Aitchison* 78 (K).

5. *Silene pseudo-verticillata*, sp. nov.

Herba perennis, caespitosa. Caulis usque 100 cm. altus. Foliis lanceolatis, usque 9 cm longis et 1.8 cm latis, scabridus. Inflorescentia usque ad 50 cm longa. Flores cymulis congestis, inter se ad 12 cm distantibus; calyx glabrus, clavatus usque ad 1 cm longus; petala integra, eligulata alba; unguis et filamenta glabra; anthophora 3 mm longa.

Plants about 100 cm tall. Stem erect, woody, minutely pubescent, internodes fistular. Leaves up to 9 cm long, 1.8 cm broad, lanceolate, scabridous, the margin and the midrib minutely spiny; sterile leafy shoots in the axils. Flowering axis about 50 cm long, leafless. Flowers forming dense opposite clusters at the nodes; internodes up to 12 cm. long; pedicels short; calyx calvate, glabrous, up to 1 cm long, base intruded, teeth acute-obtuse, slightly ciliate margin; petals not lobed, without auricles and scales; stamens with long filaments; styles 3, long; carpophore 3 mm long, shorter than the ovary. Type.

Madaglast 9000', *Chitral*, *Toppin* 530 (K).

6. *Silene longisepala* Nasir sp. nov.

Plantae perennes, ad 30 cm altitudine, decumbentes; radix ca 1 cm crassitudine; caules graciles, pubescentes; folia, linearia, pubescentia, nervis obscuris; flores terminales, solitarii, subsessiles, bracteis linearibus, brevibus, calicibus 3-3.5 cm longitudine, pubescentibus, petalis roseis vel purpureis, bifoliatis, auriculatis; carpophores duplolongiores ovariae; capsulae obovoideae-oblongae, longitudine simile carpophorum. Semina reniformia, compressa, lacunis elongatis.

Plants perennial, up to 30 cm tall; number of branches from the base, decumbent. Thick woody tap root, about one cm in diameter. Stems slender, densely pubescent, branched. Leaves narrowly linear to linear, up to 2 cm long, 2 mm broad, pubescent, venation obscure. Flowers solitary, terminal on the main or the lateral branches, shortly pedicellate or sub-sessile. Bracts similar to the leaves but shorter. Calyx tubular, 3 to 3.5 cm long, pubescent, nerves

purple. Corolla pink to purple; petals bilobed, each with 2 auricles and 2 wedge shaped scales, claw not ciliate. Carpophore twice as long as the ovary; style long, flattened, not ciliate. Capsule oval, as long as the carpophore; seeds reniform, compressed, channelled.

Type. Chitral, *Stainton* 2505 (BM).

Representative specimens. Chitral, *Stainton* 2449 (BM); Chitral, *B. Lyon* 890 (BM).

This species is related to *Silene persica* but differs in its flower colour and longer sepals and petals.

I wish to thank the Directors of the Royal Botanic Gardens, Kew and the Botany section, British Natural History Museum, London for



Fig. 1. *Silene pseudo-verticillata* Nasir. A. A portion of the shoot showing leaves and sterile branches. $\frac{1}{2}X$. B. A part of the inflorescence. $\frac{1}{2}X$. C. One petal. $1X$

the loan of the specimens, Dr. R. R. Stewart for his help and advice, Mr. R. Gallyon for the Latin diagnosis and Miss S. Daskawie for the drawings of *Silene pseudo-verticillata*.

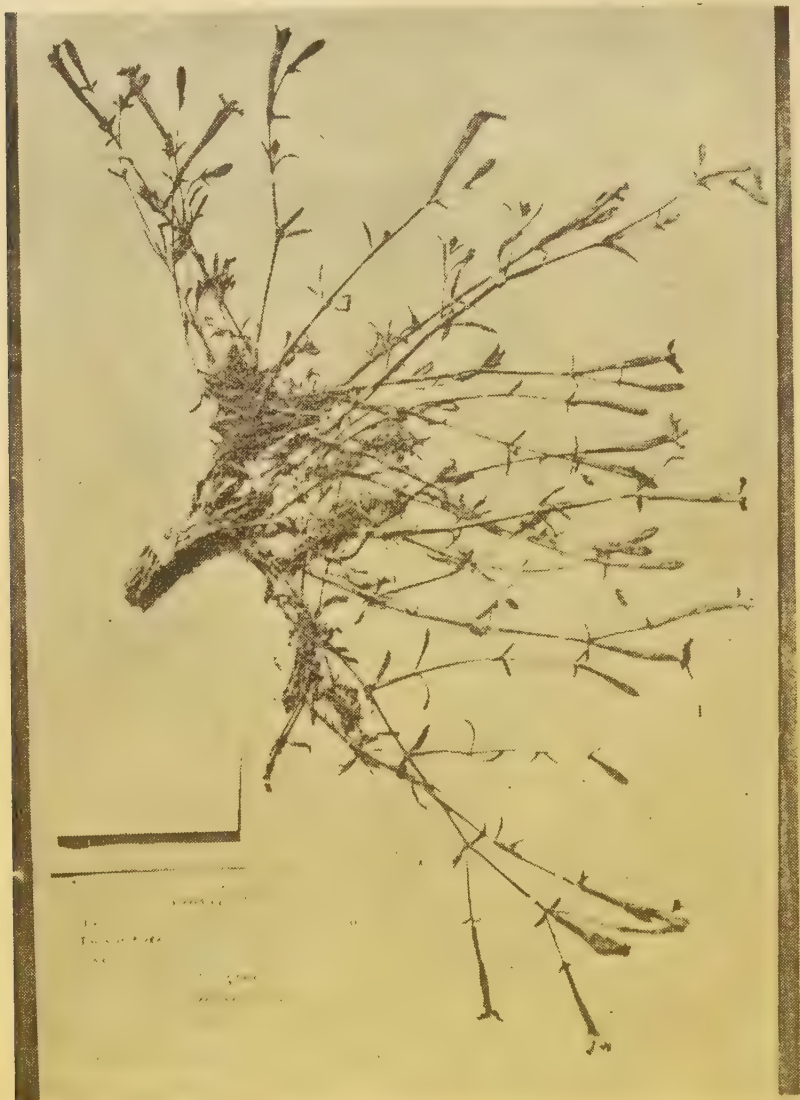


Fig. 2. *Silene longisepala* Nasir,

Possible role of unreduced gametes in the origin of polyploid

Fragaria

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The species of *Fragaria* occur in an interesting polyploid series. They are present in diploid, tetraploid, hexaploid and octoploid forms. The origin of polyploids in this genus has been the subject of much speculation. In the present paper an attempt has been made to show that the frequent production of unreduced gametes may have been the principal cause of the origin of polyploids in *Fragaria*.

While working in the University of Manchester to elucidate the inter-specific relationship between a diploid species *F. vesca* ($n=7$) and an octoploid species *F. grandiflora* ($n=28$), the author came across several instances of non-reduction. These were either of the following two kinds:—

- (1) In the first kind of non-reduction the hybrid was found to contain the sum total of the full chromosome complement of one parent and the gametic chromosome number of the other.
- (2) In the second, the hybrid showed a chromosome number higher than the sum total of the somatic chromosome numbers of both the parents.

The first case might have been the result of a union between an unreduced and reduced gamete. Double non-reduction might have led to the second kind. Such non-reduction of gametes has also been noted in this genus by earlier worker. In addition, some of their hybrids showed chromosome numbers which represented the sum total of the somatic chromosome numbers of both the parents. The hybrids showing such chromosome numbers might have been the result of either a union between two unreduced gametes or somatic chromosome doubling of the zygote. Table I shows all such cases recorded together with those observed by the author. In the light of these evidences, the origin of different polyploid groups has been explained as follows:—

ORIGIN OF TETRAPLOIDS

Schiemann (1951) has occasionally noted tetraploid individuals among the F_1 progeny of crosses between the diploid species *F. collina* ($=F. viridis$) and *F. vesca*. These tetraploid plants, according to her, bore a great resemblance to the naturally occurring tetraploid *F. orientalis*. Staudt (1951)

Table I

Authority	Crosses in which non-reduction occurred	Chromosome No.		Remarks
		Expected	Observed	
Fedorova (1934)	F_2 of <i>F. grandiflora</i> ($8 \times$) $\times$ <i>elator</i> ($6 \times$)	49	56 (3)* 63 (3), 77 (5), 84 (1), 98 (2)	Non-reduction on male, female and on both sides.
do.	(<i>grandiflora</i> $\times$ <i>elator</i>) ($7 \times$) $\times$ <i>elator</i>	45-46	91 (1)	Non-reduction on both sides or somatic doubling.
do.	F_1 of <i>vesca</i> ($2 \times$) $\times$ <i>elator</i>	28	35 (2)	Non-reduction on female side.
Lilienfeld (1933)	F_2 of <i>elator</i> $\times$ <i>nipponica</i> ($2 \times$)	28	42 (1)	Non-reduction on either male or female side.
Schiemann (1937)	F_1 of <i>collina</i> ($2 \times$) $\times$ <i>elator</i>	28	35 (1)	Non-reduction on the female side.
Schiemann (1944)	F_1 of <i>vesca</i> $\times$ <i>elator</i>	28	35 (2) 105 (1)	Non-reduction from female side and double non-reduction.
Schiemann (1951)	F_1 of <i>vesca</i> $\times$ <i>collina</i>	14	28 (several)	Non-reduction on both sides or somatic doubling.
Scott (1951)	(<i>ananassa</i> $\times$ c-tetraploid <i>vesca</i>) $\times$ <i>ananassa</i> ($8 \times$)	49	70 (6), 77 (1)	Non-reduction on hexaploid and octoploid side respectively.
Studt (1952)	F_1 of <i>orientalis</i> ($4 \times$) $\times$ <i>vesca</i>	21	28 (1)	Non-reduction on the male side.
Islam (1954)	F_1 of <i>vesca</i> $\times$ octoploid cultigen Royal Sovereign	35	42 (1)	Non-reduction on the female side.
do.	Seedlings from open-pollinated F_1 s between <i>vesca</i> and octoploid cultigen Bradley Cross	...	98 (1) 91 (1) 84 (1)	More than double non-reduction.
do.	Octoploid cultigen Perle de Prague $\times$ (Octoploid Auchincruive Climax $\times$ c-tetraploid <i>vesca</i>) ($8 \times \times 6 \times$)	...	70 (1)	Non-reduction on hexaploid side.

* Figures in the bracket indicate the number of plants obtained with that particular chromosome number.

also observed a tetraploid among F_1 s in some diploid species crosses. Hybridisation occurs freely in nature between the sympatric diploid species of *Fragaria* (Ichijima, 1930). It is therefore likely that the tetraploid species *F. orientalis* and *F. moupinensis* may have originated through hybridisation between the two overlapping diploids followed by the chromosome-doubling or by the union of two unreduced gametes from two diploids. The evidence at present available indicates that the latter has most likely given rise to the tetraploid species of *Fragaria*.

ORIGIN OF HEXAPLOID

The only hexaploid species so far recorded is *F. elatior* ($n=21$), the distribution of which is confined to Europe. Any of the two tetraploid species mentioned earlier or any of the hitherto unknown tetraploid species of Eurasia may have been the progenitor of the hexaploid species. That hexaploid plants may arise from tetraploid individuals has been shown by Lilienfeld (1933) who obtained a hexaploid from the progeny of the tetraploid hybrid between *F. elatior* and *F. nipponica* ($n=7$).

ORIGIN OF OCTOPOLOID

It is more difficult to explain the origin of the octoploids since they are confined to America where no tetraploid or hexaploid species have so far been recorded. It is assumed that the octoploids might have originated in either of the following ways:—

(1) From hitherto undiscovered tetraploid or hexaploid American species by means of non-reduction.

(2) From the tetraploid species of Eurasia e.g., *F. orientalis*, *F. moupinensis*, during the geological era between late cretaceous and early tertiary when there was still land connection between Asia and America (Schuchert, 1928) and the subsequent migration of the octoploids to America. A somewhat similar hypothesis was put forward by Harland (1942) to explain the origin of the tetraploid cultivated cotton in America, where one of the putative diploid parents is not found growing in the wild state.

Of the two alternatives, the first one seems to be more plausible since the chromosome numbers of many of the American species of *Fragaria* are not known (Schiemann, 1951) and it is likely that among these species at least some may turn out to be tetraploid or hexaploid. This assumption gains further ground from the fact that quite recently a natural triploid has been reported from America (personal communication from Harland). Until the tetraploid which may have been the progenitor of the triploid is traced, the possibility that this triploid might as well have originated from a union between an unreduced and reduced gametes of any diploid species or of two diploid species cannot be ruled out. The second alternative on the

origin of octoploid may be acceptable only when a thorough search among the American species of *Fragaria* fails in tracing any tetraploid or hexaploid species.

ACKNOWLEDGEMENT

The author gratefully expresses his indebtedness to Dr. S. C. Harland, F. R. S., lately Professor at the University of Manchester, in whose laboratory the data used in this paper were collected.

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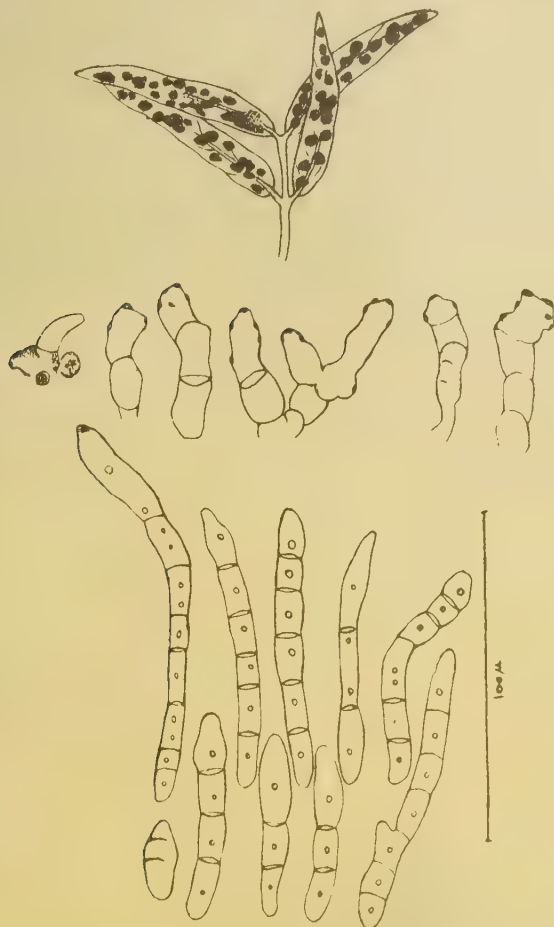
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Observation on *Cercospora salvadorae* Maire

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Cercospora salvadorae Maire (Le Botaniste, 34 : 308, 1949) is described on *Salvadora persica* from Western Sahara. It is known to have 0-2 septate



Cercospora salvadora, showing habit, conidiophores and conidia.

conidia. Chupp in his monograph on the genus *Cercospora* has observed that "the description is too meagre to be sure that it is *Cercospora*, especially since the conidia are not over 2-septate."

In February 1959, the writer collected this fungus on the leaves of *Salvadora oleoides* and *S. persica* from Tandojam, Pakistan. The microscopic examination revealed that the conidia are very often multi-septate (0-10, averaging 3 to 5 septate) and it was considered to be an undescribed species of *Cercospora* on *Salvadoraceae*. The collection was therefore referred to Kew gardens and Maire's type material was examined by Dr. M. B. Ellis in the Herbarium I. M. I. which shows that the fungus has multiseptate conidia and is indistinguishable from Tandojam material. The present collection has therefore been identified as *Cercospora salvadorae* Maire and a brief description added below to facilitate identification:—

"No definite leaf-spot at first; fruiting in amphigenous, sooty black to gray layer; stromata small, fuliginous brown, globular; conidiophores 0-3 septate, light olivaceous brown, geniculate, not uniform in width, arising in dense fascicles through stomata, rarely branched, $5-6.7 \times 23-41.8 \mu$; conidia cylindric to obclavate, light brown, plainly 0-10, averaging 3 to 5 septate, curved, ends obtuse, $3-5 \times 8-67 \mu$."

As far as known to the author, this is the first record of this fungus from Pakistan.

The writer is grateful to Dr. M. B. Ellis for kindly comparing his collection with the type material and to the Director, C. M. I., Kew for valuable information on this parasite.

Functional Morphology of the Mandible in Crustacea

Part I. Branchiopoda*

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INTRODUCTION

In literature, there is very little information on the functional aspect of the mandibles in the Crustacea, though a detailed description of their external morphology in various groups is available. For example, in the Branchiopoda Ocioszynska-Bankierowa (1933) and Ocioszynska-Wolska (1936), have described the structure of the mandibles of the Anostraca and Conchostraca very thoroughly, but they have not attached any functional significance to the differences found in them. Recently, Snodgrass (1950) has made a comparative study of the mandible in the whole of the Arthropoda, but the study of his work shows, however, that apart from the mandibles of the Decapoda, the information he has given for the Crustacea is incomplete. In the present work an attempt has been made to study the mandible from the aspect of functional morphology.

The number of the examples which could be studied was limited. Only such species were chosen, as were available and which illustrated the range of the group. The technique adopted has been to examine the structure of the appendage itself, after isolation from the animal. Musculature has been mainly studied by isolation of the mandibular segment and then by clearing it in oil. In some cases thin wax sections or thick colloidin sections have been used for confirmation. It has been found that the main features of the musculature could be studied adequately by the methods adopted above. For the preparations of the permanent mounts in Canada Balsam, the material has been variously stained using Chlorazol black for whole mounts and the same stain or Haematoxylin and Eosine for sections. Temporary preparations have been studied unstained, using lactic acid or when stained using Clove oil as clearing agent. Sectioned material was first fixed in Formalin or Alcoholic Bouin.

My sincere thanks are due to Professor H. Graham Cannon, F. R. S., for suggesting the problem and for the advice and encouragement which he has given to me in the progress of the work. I am grateful to

*Part of the work presented to the University of Manchester for the Degree of Doctor of Philosophy.

him also for the loan of his prepared slides of *Lepidocaris rhyniensis*, *Daphnia magna* and *Bythotrephes longimanis*. I am especially indebted to Dr. E. J. Iles for his continued help and valuable suggestions during the course of this work. I would like to thank Dr. J. P. Harding of British Museum (Natural History), London for identifying *Caenestheria propinqua* for me and Professor R. Dennell for helping me with the technique and for his valuable suggestions in preparing this manuscript.

My thanks are also due to Dr. Muzaffar Ahmad, Reader in Zoology, University of the Panjab, Lahore for critically reading the manuscript.

DESCRIPTION OF MANDIBLES

A. ORDER ANOSTRACA

Chirocephalus diaphanus (figs. 1-5)

The mandibles in *Chirocephalus diaphanus* are symmetrically arranged behind the head. They are articulated on the tergum of the mandibular segment, which is a small but a distinct plate between the head and the maxillary segment. The tergum at the point of the articulation of the mandibles, is rather thick (fig. 1). The conical upper part of the condylar head projects freely upwards.

The body of each mandible consists of two parts (figs. 4 and 5), the upper main cuplike portion, containing a large mass of muscle, and the lower small gnathal lobe. This latter is a short stumpy portion situated almost at right angles to the former, with the masticatory surface on the median side. The masticatory surfaces of the mandibles face each other in the mid-ventral line of the body. They are not symmetrical, the left being longer and narrower than the right. They are different in their structure also.

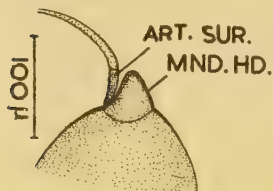
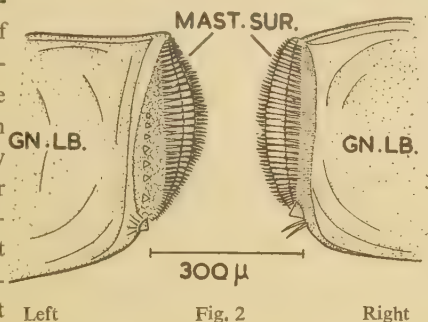


Fig. 1

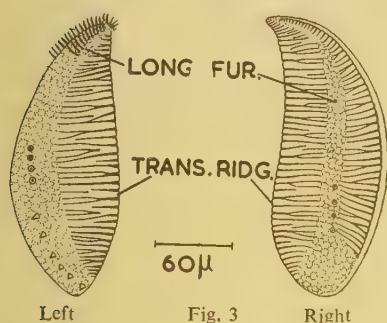
When viewed from above (fig. 3), the masticatory surface of the right mandible is elongated and parallel with the longitudinal axis of the body of the animal. The posterior margin is round and broad while the anterior margin gradually becomes narrower and is directed ventrally. The dorsal margin is smooth and arched but the ventral margin is wavy. There are transverse ridges on the masticatory surface separated by furrows. These ridges are low over the surface and more elevated near the margins. They are arranged in two groups due to the presence of the longitudinal furrow almost in the middle of the masticatory surface. This longitudinal furrow is broad at the posterior margin and gradually becomes narrow towards the anterior end. The ridges dorsal to the longitudinal furrow are different

in number and arrangement from the ventral group. In the specimens examined, there are 40 to 45 in the dorsal and about 55 in the ventral group. The dorsal ridges are broad undivided excepting few, and do not extend into the longitudinal furrow, whereas the ventral are narrow, often divided and extend into the longitudinal furrow, ending in a small network. The pattern of the ridges over the masticatory surface according to Ocioszynska-Bankierowa (1933), is a specific distinction. The ridges are made of teeth arranged in rows. The structure and the arrangement of the teeth of all the ridges is the same in the middle region of the masticatory surface, but different at the anterior and the posterior regions. In addition to this elaborate arrangement of teeth over the masticatory surface, there is one short but stout



tooth (fig. 2) near the posterior margin, just dorsal to the middle line. More peculiar are two or three spines which are in close association with this tooth. These three spines are much longer than the rest of the marginal spines and form a separate group, perhaps for cleaning the under surface of the other mandible.

On the masticatory surface of the left mandible (fig. 3) the longitudinal

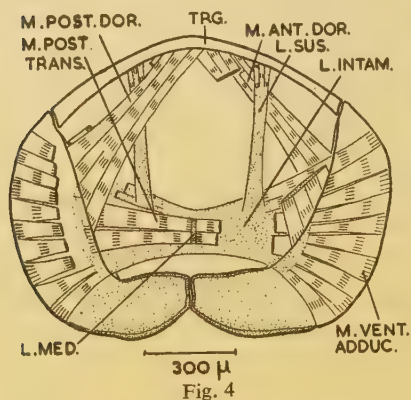


furrow is restricted to the anterior 1/4 of the masticatory surface. The ventral group of transverse ridges extends 2/3 the length dorsally to merge into the small network. These ridges are also high near the ventral margin and branch only in the middle region of the masticatory surface. Their number also varies and in the specimen shown in fig. 3 there are about 45. Starting from

the anterior end on the dorsal margin, there is a single row of teeth, extending to only 1/4 the distance behind. The teeth near the tip of the masticatory surface are longer than the rest in the row. The dorsal ridges on the anterior portion of the masticatory surface are very small, about ten in number. Behind these the whole dorsal portion is occupied by a big network. The posterior dorsal half of the masticatory surface (fig. 2) has seven stout teeth in addition to the one at the

posterior margin. The tooth at the posterior margin may be considered as homologous with a single tooth at the posterior margin of the masticatory surface of the right mandible.

The mandibles are of pendant type and the musculature (figs. 4 and 5) differs greatly from the *Eubranchipus vernalis*. Hay, sketched by Snodgrass (1950, p. 14, fig. 2 B) as typical of Anostraca (Branchiopoda). The most striking of all is the ventral adductor muscle (M. VENT. ADDUC.), which almost fills the whole cup of the mandible. The convergent ends of this from each mandible unite to a median ligament also known as intermandibular ligament (L. INTAM). The median ligament when examined from



(Reconstruction showing musculature)

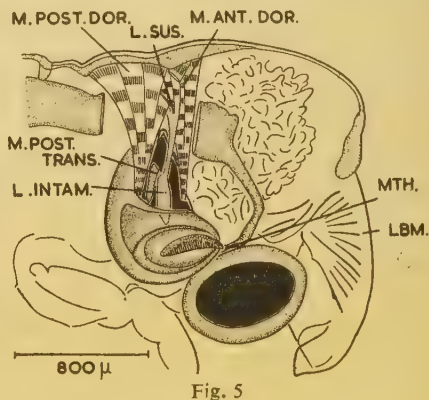


Fig. 5

the anterior side, is narrow in the middle and expanded at the sides. Its lateral margins are rounded, and the posterior lateral part of each extends into the cavity of the cup of the mandibles. The intermandibular ligament is suspended in its position by two suspensory ligaments (L. SUS.), one on each side, from the dorsal body wall. The suspensory ligaments, throughout their length, are homogeneous except at their upper 1/3 portion where they show slight traces of muscle fibres. Each is attached to intermandibular plate on its anterior face near the lower margin. The bands of the ventral adductor muscles occupy different positions in the dorsal and ventral halves of the cup of the mandible. In the dorsal half the upper bands are attached near the middle but in the ventral half the attachment is limited to the surface extending from the middle to the anterior wall. The upper two bands, from near the condylar head of each mandible are joined to the intermandibular ligament, in the middle dorsally, while the rest of the bands are confined to its lateral margins. Posterior to the ventral adductor there are two transverse muscle bands (M. POST. TRANS.), running straight from

mandible to mandible and joined to the very narrow median ligament (L. MED.). In the mandibular cups, the attachment of these muscle bands is confined to the posterior wall only. The anterior dorsal (M. ANT. DOR.) is attached to the anterior wall in the middle of the upper half of the mandibular cup. It is a narrow band running obliquely upwards to join the dorsal body wall near the middle. The posterior dorsal muscle band (M. POST. DOR.) is much broader than the anterior dorsal and is attached to the greater part of the margin of the posterior wall of the mandibular cup. Before joining the dorsal body wall, part of the muscle band overlaps the anterior dorsal muscle band.

The actual working of the mandible was studied on live *Artemia*, because of the close resemblance of the structure, position and musculature in both animals, excepting for the absence in *Artemia* of a median ligament between the posterior transverse muscle bands of the two sides. It was observed that in the simultaneous forward rocking of the body both the mandibles, first the anterior edges of the gnathal lobes are brought back a little, but close together. This was followed by a forceful backward stroke when the body of the mandibles rocked backwards. This brought the masticatory surfaces together and at the same time swung them forward almost with a jerk. After the completion of this swing the gnathal lobes were pulled apart before the anterior edges met again. Occasionally, an extreme separation of the gnathal lobes was also observed.

When these movements are correlated with the musculature in *Chirocephalus*, it can easily be deduced that the mandibles are held in their position by the ventral adductor muscle with all its elaborate arrangement, against a fixed articulation on the dorso-lateral side of the body. The forward rocking is caused by the anterior dorsal muscle. As it is not so powerful, this movement of the mandibles, with which the anterior tips of the masticatory surfaces are brought together is slow. In the backward swing, both the posterior dorsal muscle and the posterior transverse muscle bands act together with the result that the back rocking of the body of the mandible or the forward movement of the gnathal lobes is powerful and with a jerk. No muscles for the abduction of the gnathal lobes and no other mechanical structure for this could be found. Furthermore, no such mechanism could be seen in live specimens of *Artemia*. A possible explanation for this type of abduction is that it may resemble that of the abduction of the posterior limbs. To quote Cannon (1932) "....., presumably because the limbs are extremely thin-walled for their movement requires a certain blood pressure". The internal blood pressure in the mandibular segment especially near the ventral half may be responsible for abduction when

the adductor muscles are relaxed. In order to establish this, in many specimens the arthrodial membrane at the base of either the right or the left mandible was punctured. Movement of the mandible stopped, but after some time the animal also collapsed, so that the results were not conclusive. The filtered food passed on to the mandibles will be ground further by the masticatory surfaces and the upper row of eight teeth on the left and the single tooth of the right will probably help in pushing the food forward. Finally the food will be pushed into the oesophagus by the anterior row of large teeth on the masticatory surface.

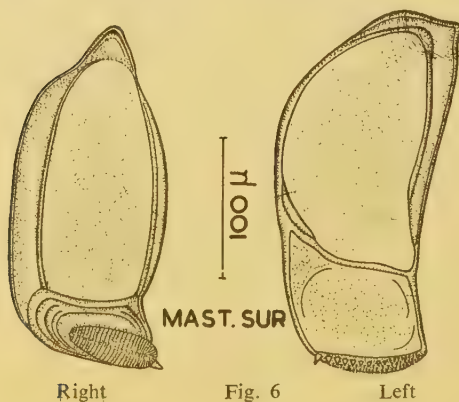
B. ORDER LIPOSTRACA

Lepidocaris rhyniensis (fig. 6.)

"There can be no doubt that in general appearance the Rhynie Chert Crustacean (male as well as female) must have looked exceedingly like a very diminutive *Branchipus*, *Chirocephalus*, or other typical Anostracan." This statement of Scourfield (1926; p. 155) about the general appearance of the animal is equally true of the mandibles. Scourfield's restoration of the animal (1926; Plate 21; fig. 3) clearly shows the position of the mandibles on the body which are symmetrically arranged behind the head, and articulated with the tergum of the mandibular segment on the dorso-lateral sides. The mandibular segment in the restoration is shown only by a slight groove. Looking at the shape of the condylar head of the mandibles, the type of the articulation must have been the same as in *Chirocephalus*.

The cup of the mandible is large and the gnathal lobe nearly at right angles to it. The masticatory surfaces of the right and the left

mandibles are different both in shape and structure. The right masticatory surface as in *Chirocephalus*, is broad posteriorly and narrow anteriorly. The dorsal margin is smooth and the ventral wavy in appearance. A definite longitudinal furrow is not present, the transverse ridges being continuous. Scourfield has also sketched the transverse ridges as continuous, in his diagram 13 A. It was not possible to count the transverse ridges because of the



poorly preserved condition in all the preparations. A single large tooth is present, but nothing homologous to the three closely associated spines was seen. On the masticatory surface of the left mandible there is again no sign of the longitudinal furrow and the transverse ridges are continuous from dorsal to ventral margin. On the upper margin, as in *Chirocephalus*, there is a row of teeth, the number of which is variable from 7 to 9. The posterior-most tooth is homologous with the posterior single tooth on the masticatory surface of the right mandible.

All these features suggest that the pattern of the masticatory surface though resembling closely that of *Chirocephalus*, was simpler. This simplicity in structure could be correlated with function, in relation to the function of the other limbs. As Cannon (1933; p. 332) has shown, only five pairs of limbs were used in filtering the food, and structure were close to the ancestral type, an intermediate stage leading to *Chirocephalus*.

C. ORDER CONCHOSTRACA

Caenestheria propinqua (figs. 7-10.)

The mandibles, as seen from the posterior side of the body, are symmetrical in their upper half and asymmetrical in the lower. This is because in this lower half, the right mandible is slightly larger and broader than the left also because the gnathal lobe of the left overlaps the right ventrally. The tergum of the mandibular segment is not so well marked as in *Chirocephalus*, but can be seen from the raised portion on the lateral sides, where the mandibles articulate with that region of the body. This

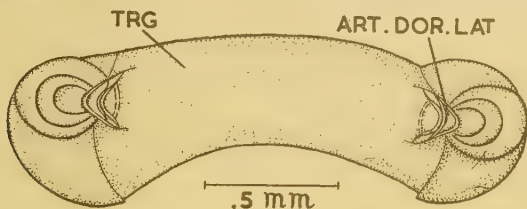
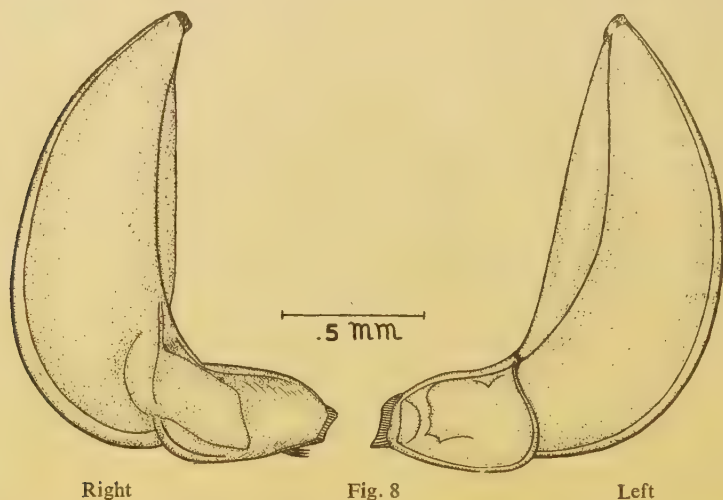


Fig. 7 (Dorsal view)

dorso-lateral articulation (Fig. 7. ART. DOR. LAT.) is very prominent and in a way different from *Chirocephalus*, because the condylar head of the mandible has no cone-like projection, extending dorsally over the articular surface on the body, but fits almost under it. This difference may be correlated with the well-developed carapace (not shown in the figure).

Perhaps the most characteristic feature of the mandibles of the Conchostraca is that the gnathal lobe of the left overlaps the right (Figs. 8 and 8). In structure and arrangement both the right and the left mandibles of

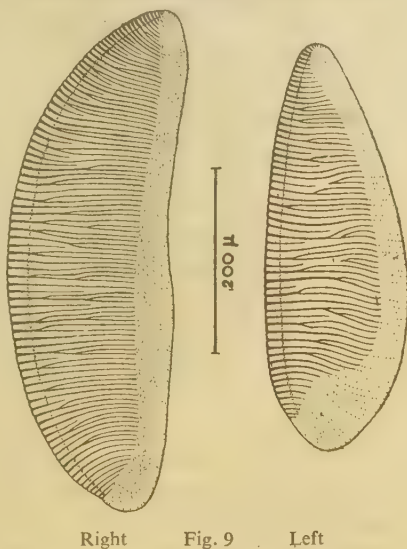
Caenestheria resemble those of *Cyzicus tetracercus* described by Ocioszynskia-Wolska (1936). The gnathal lobe of the right mandible (Fig. 9) is slightly larger than the left and compressed dorso-ventrally, with broad anterior margin and narrow posterior margin. There is a group of six long spines (Fig. 8) on the ventral side at the junction of the gnathal lobe and the masticatory



surface. These spines are bent upwards. When seen from above the masticatory surface is oval in shape (Fig. 9), with a broad anterior margin gradually becoming narrow posteriorly. The masticatory surface is sunk longitudinally in the middle but there is no longitudinal furrow as found in *Chirocephalus*. The margins of the masticatory surface are raised and the dorsal is more elevated than the ventral. Transverse ridges or the lamellae are present on the masticatory surface and their number near the dorsal margin varies from 100 to 140. The ridges are not single but branched, especially near the dorsal margin, but some of them run singly to the ventral margin. At the anterior region of the masticatory surface, the ridges are so close that it is difficult to distinguish them, whereas at the posterior margin these are very clear. The ridges near the dorsal margin extend upward from the masticatory surface, become flat and are so close to each other that they give an appearance of continuity. All the transverse ridges disappear near the ventral margin. In the anterior part, the ridges are not regularly distributed but are scattered to form a network. For this reason the ventral margin is not continuous, but wavy in appearance.

The gnathal lobe of the left mandible (Fig. 9.) is a little smaller than that of the right mandible and no long spines are present on its ventral side

near the masticatory surface. Both the anterior and posterior margins of the gnathal lobe are approximately of the same length. The left masticatory surface is, however, different in shape from the right, perhaps for the reason that it overlaps the right. It is also oval in shape with broad anterior and the narrow posterior margins. The masticatory surface is sunk near the middle, in the antero-posterior direction thus producing a dorsal and a ventral wall. The ventral wall is twice as high as the dorsal wall of the masticatory surface of the right mandible. Transverse ridges to the lamellae are clearer near the ventral margin; these branch variously and disappear into the network near the dorsal margin. This network also extends near the ventral part of the anterior margin where the ridges are very small. The ridges are drawn on from the ventral margin, expand, and give a continuous appearance like the dorsal margin of the right masticatory surface.



The musculature (Fig. 10.) resembles that of *Chirocephalus* in many respects. The enormously developed ventral adductor muscle (M. VENT. ADDUC.) fills up the cup of the mandible. The intermandibular ligament or plate (L. INTAM.) to which these are attached, is narrow in the middle and expanded at the sides. It is attached to the dorsal body wall by two narrow suspensory ligaments (L. SUS.), one on each side. Transverse muscle bands (M. POST. TRANS.) posterior to the intermandibular ligament, are continuous from mandible to mandible, but unlike *Chirocephalus* do not have a narrow ligament in the middle. In the cup of each mandible, the bands of the posterior transverse muscles are limited to the lower 2/3 portion. The anterior dorsal (M. ANT. DOR.) is a fairly wide band occupying almost the greater part of the anterior margin of the cup in the middle. The posterior dorsal (M. POST. DOR.) is a little wider than the anterior, but occupies the same position on the posterior margin, and runs almost parallel with the anterior dorsal. Both the anterior and the posterior dorsal muscle bands along with the suspensory ligaments, curve round the oesophagus before joining the dorsal body wall.

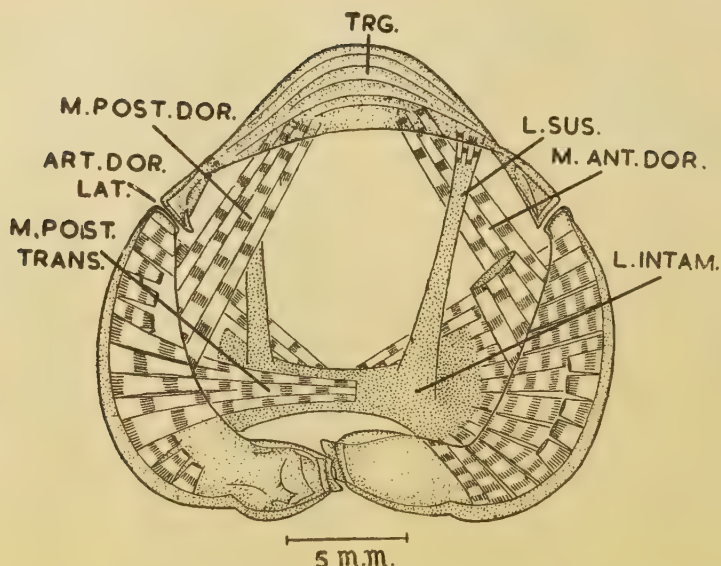


Fig. 10. (Reconstruction showing musculature).

In the movement of the mandibles the first important difference to note from *Chirocephalus*, is the dorsal articulation which, though on the lateral side of the body, is practically, dorsal, due to the lateral extension of the tergum. This would give a free movement to the mandibles in every direction. Both the mandibles are held in position by an elaborated ventral adductor muscle. Only forward and backward rocking movements would be possible. The backward rocking would be very forceful as compared with the forward, because both the posterior dorsal and the posterior transverse muscle would be acting together. The overlapping of the masticatory surfaces would help in grinding the filtered food more thoroughly. Unlike *Chirocephalus* there are no special teeth on the masticatory surface of either mandible for pushing the food forward towards the mouth. Perhaps the general grinding and sweeping action of the masticatory surface of one over the other help in this. Abduction of the gnathal lobes, if it takes place at all, is as difficult to explain as in the case of *Chirocephalus*. As live specimens were not seen, it is difficult to analyse with certainty how the mandibles move.

D. ORDER CLADOCERA

Daphnia pulex (figs. 11-13)

The mandibles of *Daphnia pulex* look very much like those of *Caenestheria propinqua* in their general appearance. They lie in a groove formed by the bases of the antennae on the head and the rest of the body

behind, partly covered over by valve on each side. Ventrally they are covered by a massive labrum which extend as far as the second trunk limb. Laterally, the mandibular segment is only marked by the articular surface on each side near the margin of the tergum. The dorsal part of the tergum as seen in section, instead of being oval is raised far above into a cone. When observed from the anterior side of the body the mandibles are symmetrical in the upper half and asymmetrical in the lower. This asymmetry, like *Caenestheria*, is due to the broad gnathal lobe of the right mandible, and the masticatory surface of the left covering the right ventrally (Fig. 12 and 13). The dorso-lateral articulation also resembles *Caenestheria*, and the condylar head is fixed below the articular surface of the tergum (not shown in the figures).

The gnathal lobe of the right mandible (Fig. 11) as mentioned above, is flatter than the left. The masticatory surface when examined from above, is oval in shape with broad anterior and narrow posterior margins. It is not flat but, like *Caenestheria*, is sunk in the middle, having raised side walls, the dorsal of which is higher than the ventral.

The transverse ridges are not close together but are single

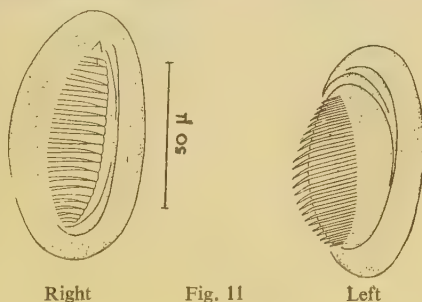


Fig. 11

or branched and run straight. These are narrow when they start from the upper surface of the dorsal margin, and near the ventral margin are broad and very close to each other, with the result that the ventral margin appears to be smooth. The number of the ridges counted in the various specimens varies from 22 to 30 or more. The arrangement of the spines on the ridges could not be made out clearly but appears to be rows of three spines arranged transversally. The most characteristic feature of the masticatory surface of the right mandible, however, is the presence of a single large tooth on the posterior margin. The tooth from its nature and position can perhaps be homologised with the single tooth on the masticatory surface of the right mandible of *Chirocephalus*.

The masticatory surface of the left mandible (Fig. 11) is different from the right. It is oval in shape with a broad anterior and slightly narrow posterior margin. The masticatory surface is also sunk in the middle with raised margins, the ventral of which is higher than the dorsal. The transverse ridges are very broad and close to each other near the dorsal margin

but very narrow and wide apart near the ventral margin. From the ventral margin these extend downwards for a considerable distance and are directed forwards. The number of ridges varies from 18 to 25 or more. The arrangement of spines is best seen when the masticatory surface is examined from the anterior or the posterior side. The dorsal margin of the masticatory surface is without any row of teeth or anything homologous to the single posterior tooth present on the masticatory surface of the left mandible.

The musculature of *Daphnia pulex* though showing the same basic

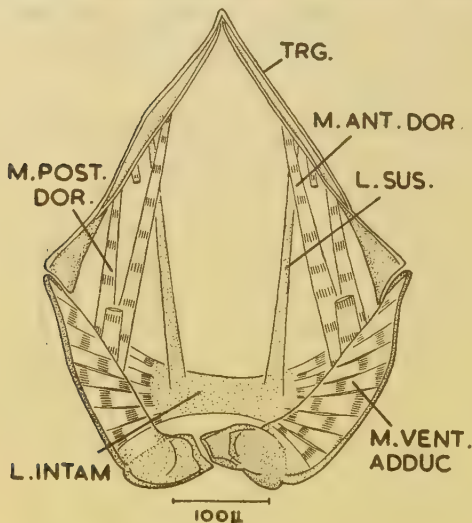


Fig. 12
(Reconstruction showing musculature).

pattern as seen in *Chirocephalus* and *Caenestheria*, is still different from it in certain features. The anterior (Fig. 12. M. ANT. DOR.) and posterior (Fig. 13. M. POST. DOR.) dorsal muscles as usual are attached to the dorsal body wall and on the mandibles, a little above the middle of the anterior and the posterior wall of the cup. The ventral adductor (Fig. 12. M. VENT. ADDUC.) from each side is attached to an intermandibular ligament (L. INTAM.) in the middle. This is connected to the dorsal body wall by two suspensory ligaments, one on each side. The intermandibular ligament is thin, narrow in the

middle and transparent. Behind this the two bands of the posterior transverse muscle (Fig. 13. M. POST. TRANS.) are continuous from mandible to mandible. In addition, above these there are two bands of the upper transverse muscle (M. UPP. TRANS.), which instead of being inserted on the posterior wall of the cup, merge with the fibres of the posterior dorsal muscle, on each side, near their attachment with the mandibles. This perhaps forms the most characteristic feature of the mandibular musculature of *Daphnia*.

The movements of the mandibles were studied on live specimens and were found to be very different from those seen in *Artemia*. The left mandible remained stationary and whenever it showed any movement, however slight, it was quite independent of the right mandible. In very rare instances both the mandibles moved simultaneously, though the move-

ment of the left in every such observation was restricted. The mandible swung back with a jerk in such a manner that the gnathal lobe was almost turned through 90 degrees, with the result that the masticatory surface was facing the mouth opening. With the same jerk the right mandible was brought back to its original position. The gnathal lobes were seen moving apart occasionally but at not regular intervals. The labrum was also seen moving up and down independently of the movements of the mandibles.

Judging from the above observations it is concluded that basically the mandibles show the same type of movements as seen in *Artemia*, but somehow or other, the movement of the left is hampered while the right moves freely. A search was made to

find the cause for the restricted movement of the left mandible. For this the mandibles were carefully examined in both live and dead specimens. As far as the dorso-lateral articulation is concerned, no visible difference was seen in the right and the left mandible of the same animal. Also nothing near or on the base of the gnathal lobe of the left mandible was seen which would prevent its movement. The movement of the right mandible to almost 90 degrees will be aided especially by the set of upper transverse muscle bands. Perhaps the peculiar arrangement of these bands is the reason for the restricted movement of the left. The movement of the right is justified by the presence of a single large tooth at the posterior margin of the masticatory surface. The left which showed no movements has no corresponding row of teeth.

(b) *Leptodora kindti* (Fig. 14)

The mandibles of *Leptodora kindti* are situated behind the head hidden between the bases of the antennae and the anterior rim of the thorax which partly covers it from behind. When examined from the ventral side of the body, the mandibles are seen to be folded like the arms and are symmetrical in position. The cup of the mandible is oval in shape and at the dorsal margin it is produced above into a short triangle-like articular head which abuts against the well-developed, articular surface of the tergum

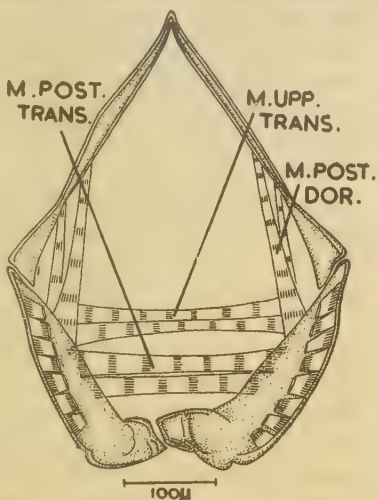


Fig. 13
(Reconstruction showing musculature).

(ART. DOR. LAT). The cup of each mandible is inclined in such a manner that the posterior wall appears to be larger than the anterior. The gnathal lobe (GN. LB.) are very long, twice as long as the cup. They become gradually slender towards their tips. Each is projected into the buccal cavity from the sides at the junction of the upper (labrum) and lower (hypostome) lips. In some preserved specimens these were seen coming out from the other sides after crossing each other in the middle. There is no difference in the armature of the right and left gnathal lobes. There are four teeth on the inner side of each. The one at the end is the longest and medially curved, the second is situated at a distance from the first and the third and fourth are almost at equal distance. The third tooth is the smallest of all.

In the musculature, the anterior dorsal muscle (M. ANT. DOR.) is about twice as long as the posterior dorsal (M. POST. DOR.) and this perhaps is due to the permanent inclined position of the rim of the mandibular cup. The posterior dorsal muscle is, however, broader than the anterior dorsal. The ventral adductor muscle (M. VENT. ADDUC.) does not fill the cup of the mandible; instead its bands are limited only to the anterior wall. In the middle these are connected to a very narrow band-like intermandibular ligament (L. INTAM.), which is without any suspensory ligaments. The

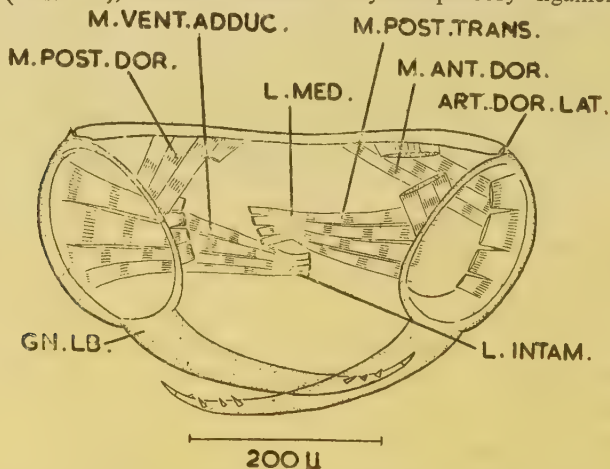


Fig. 14. (Reconstruction showing musculature).

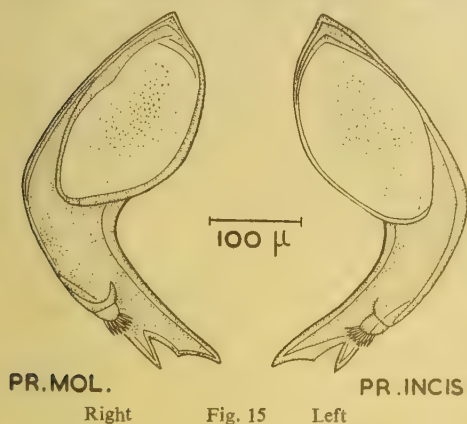
bands of the posterior transverse muscle (M. POST. TRANS.) are inserted close to the margin of the posterior wall of each mandibular cup. In the middle these are also connected to a very narrow median ligament (L. MED).

The food as described by Forrest (1879), chiefly consist of water insects and other living animals. It is captured by the limbs arranged round a circular disc at the anterior end of the thorax. The animal once caught

is made to travel towards the base due to the setation on the limbs. When the prey reaches the base, the head flexes down and the mandibles, along with the lips, fit into the cup formed by the bases of all the limbs. The upper lip (labrum), which is movable, completely encloses the cup and the mandibles begin to work. The actual movement of the mandible could not be studied due to the non-availability of live material and it is rather difficult to say how the gnathal lobes can move apart to such a distance as to bring the teeth opposite to each other. Perhaps the anterior dorsal muscle along with the ventral adductor act together and rock the body of the mandibles to more than 90 degrees forward, with the result that the gnathal lobes are pushed outwards. Similarly the joint action of the posterior dorsal and the posterior transverse muscles will rotate the body of the mandibles back and the opposing teeth of the gnathal lobes will tear anything brought between them.

(c) *Bythotrephes longimanus* (figs. 15-17)

The mandibles of *Bythotrephes longimanus* differ very much in their general shape from *Leptodora kindti*. They are symmetrically arranged behind the bases of the antennae and the first leg. The dorso-lateral articulation is well defined as in *Caenestheria propinqua*. The dorsal tergum is produced into a ridge (Fig. 16. RDG.) and on the lateral side it comes out to form an articular surface for the condyler head of the mandible. The upper tip of the condyler head of the mandible is produced into a cone which projects freely above the articular surface of the tergum. The cup of each mandible is quite large and



the opening on the median side is inclined antero-posteriorly like *Leptodora*.

The gnathal lobes (Fig. 15) are dorso-ventrally flattened and bent almost at right angles to the cup. Ventrally, they are covered over by a labrum which has its own characteristic shape. The paragnaths behind are large lobes and each is provided on its posterior median margin by a small spine. The gnathal armature is the same in both mandibles. Each gnathal lobe is divisible into two portions as in Malacostraca. The posterior

portion (incisor process: PR. INCIS.) is larger and dorso-ventrally more flattened than the anterior. It has two sharp teeth, one at the anterior and the other at the posterior margin. There is one very small knob-like tooth between these two teeth. The tip of the posterior large tooth is directed towards the mouth. In all the specimens examined, the teeth of the two mandibles were seen alternating with each other. The anterior portion (molar process: PR. MOL.) is small and lobe-like with a bunch of small stout spine and is projected towards the mouth.

In musculature (Figs. 16 and 17) it differs from *Leptodora* and more closely resembles *Daphnia pulex*. The posterior dorsal muscle (M. POST. DOR.) is divided in two bands, one long joining the body wall and overlapping the one from the other side in the mid dorsal line. The other short band runs straight and is joined to the dorsal body wall on the lateral side, but the important feature about this muscle is that it is somewhat tendinous near the attachment with the mandible. The anterior dorsal muscle (M. ANT. DOR.) is very short, non-tendinous and is inserted on the under side of the ridge, which project out on the lateral sides to form the articular surface for the condylar head of the mandible. The bands of the ventral adductor muscle (M. VENT. ADDUC.) coming from the anterior part of the cup of each mandible are united in the middle to a narrow inter-mandibular ligament (L. INTAM.), without any suspensory ligaments. The bands of the posterior transverse muscle (M. POST. TRANS.) are continuous from mandible to mandible, as in the majority of other Branchiopods. In addition to this posterior transverse muscle there is the upper transverse muscle (M. UPP. TRANS.) the bands of which like *Daphnia*, are joined on either side to the lower half of the posterior dorsal muscle.

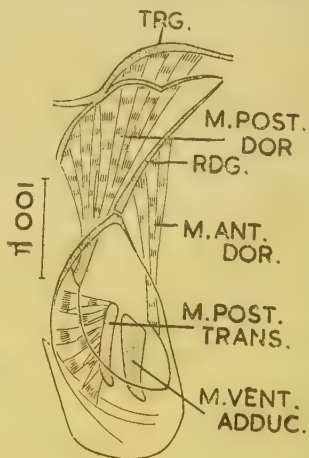


Fig. 16. Lateral view of the outer side showing arrangement of various muscles.

The limbs and the arrangement of the setae and the spines on them clearly suggest that this animal may be capable of catching large food mass. If the animal feeds on large masses, then an abduction movement of the mandibles will be necessary. Whether this abduction takes place as in *Leptodora* is difficult to say, because the ventral adductor is not inserted actually on the anterior wall of the cup of the mandible as in *Leptodora*, though found close to it. The abduction is also not possible due to the joint action of all the dorsal

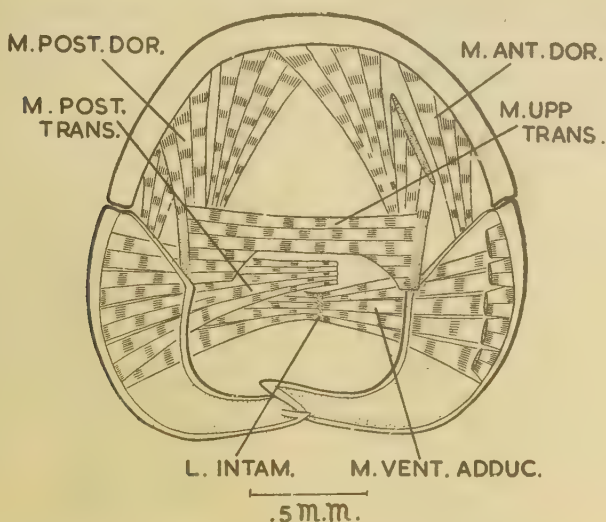


Fig. 17. (Reconstruction showing musculature).

muscles, because of the peculiar nature and position (posterior median angle of the cup) of the posterior dorsal muscle. Its division into two, and its tendinous nature, and the angle of insertion, suggest that it might help in pulling the gnathal lobes medially and upwards and likewise the action of the anterior dorsal muscle will pull it down and to some extent backwards.

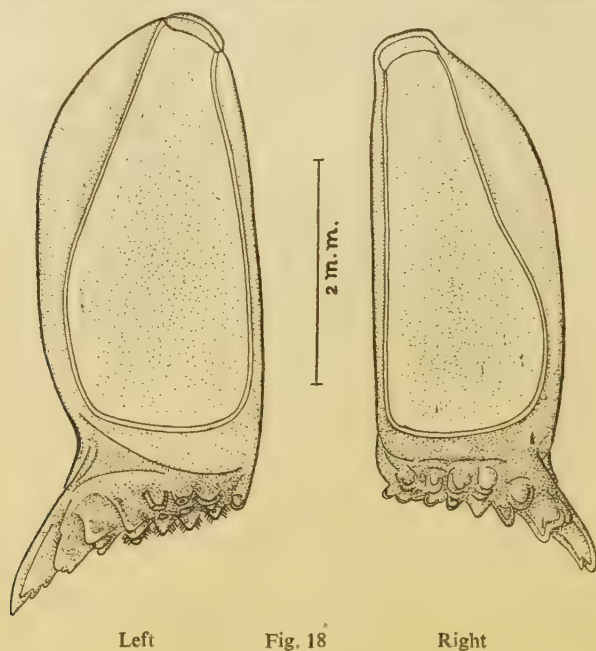
E. ORDER NOTOSTRACA

Apus glacialis (figs. 18-22.)

The mandibles in *Apus* are arranged symmetrically and articulated as described by Snodgrass "on the under side of the lamellar fold of carapace." This dorsal articulation (Fig. 21, ART. DOR.) is entirely different from the other Branchiopoda, e.g. *Chirocephalus*, *Caenestheria* and *Daphnia*. It appears to be a modified form of the dorso-lateral articulation which has taken a dorsal position due to the extension of the carapace on the lateral side from that point. When the animal is observed from the dorsal side, the carapace appears to be a little raised in that region under which the mandibles articulate. The articular surface on the under side is a shallow depression, the chitin of which is thicker than the surrounding region. Excepting this the tergum of the mandibular segment is not so clearly marked as in *Chirocephalus*.

The mandibles as observed on the body in their natural position are

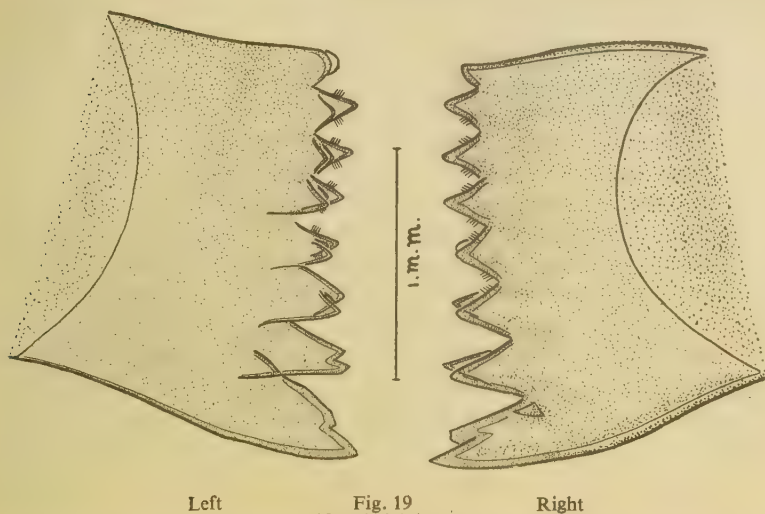
so arranged that the opening of the coxale cup is always directed anteriorly;



thus making the posterior wall of the coxale cup larger than the anterior wall. The anterior wall of the cup is, however, straight. The upper head portion of the mandible is broad, smooth, and slightly curved so as to fit incompletely in the chitinous depression on the under side of the carapace.

The gnathal lobes (Figs. 18-20) are entirely different from those of the Branchiopods described above. It is dorso-ventrally flattened, curved almost at right angles to the coxale cup, and when it is viewed from the median side (Fig. 20) or when the mandibles are seen from the back, the posterior region is seen to be drawn back postero-medially. This drawn out portion of the gnathal lobe is quite thin as compared with the anterior portion and appears to be a separate part. The gnathal lobe is so inclined antero-posteriorly that it fits between the anterior lip and the paragnath behind. The masticatory edge (Figs. 18 and 19) is narrow and armed with both teeth and spines the arrangement of which is different in the right and the left mandibles of the same animal.

There are altogether 8 teeth on the right mandible, 6 on the straight portion and two on the drawn out posterior margin. At the anterior margin the first tooth is of a reduced cone shape with a group of setae on



Left

Fig. 19
(Gnathal lobes).

Right

its ventral side springing from its base. From the second to the sixth tooth the structure is the same. Each has three cones arranged transversally to the longitudinal axis of the masticatory edge. In each tooth the middle cone appears to be a little smaller than the lateral. On either margin of the lateral cone of these teeth (excepting the posterior margin of the sixth) there is a group of small spines arranged in a series near the bases. The seventh tooth on the drawn out posterior margin has the same structure as the sixth, but there are no spines on either margin of the dorsal cone. The eighth or the posteriormost tooth is different from the rest. It has only two elongated cones the dorsal of which is very well developed, and is sharp and pointed, while the ventral is

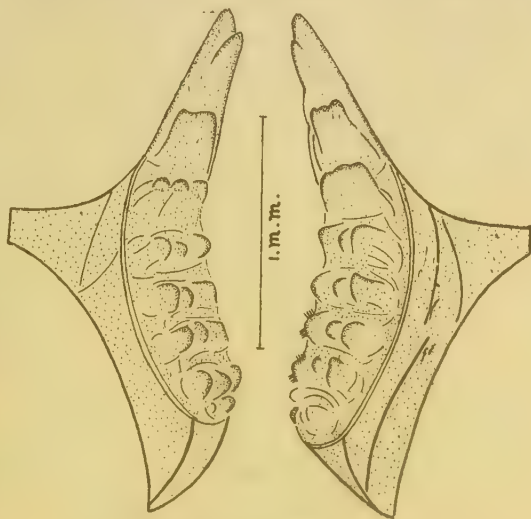


Fig. 20. (Gnathal armature) median view.

is different from the rest. It has only two elongated cones the dorsal of which is very well developed, and is sharp and pointed, while the ventral is

small and has a truncated margin. At the base of the dorsal cone on the anterior side there is one small tooth-like spine, sometimes projecting between the last two teeth. This forms the characteristic feature of the gnathal lobe of the right mandible. The interpretation of the cones would be quite different if this was to be regarded as a reduced dorsal cone of the last (eighth) tooth.

Although the number of teeth on the masticatory edge of the gnathal lobe of the left mandible is the same, they show a marked difference from the right. The first small cone-like tooth at the anterior end is small, and sharper than the right one. Ventral to this there is a group of spines, which appear to be arranged on a slightly raised cone. From the second to the fifth the teeth are almost identical and have the same structure as on the right; but the marginal spines, instead of being on the dorsal are now on the ventral cone. The sixth and seventh teeth have the same structure but are devoid of spines. The dorsal cone of the eighth tooth is sharp and long, while the ventral is reduced and becomes more confluent with it. There is no tooth-like spine on the base of the dorsal cone.

Along with the structure of the gnathal lobe the musculature (Figs. 21 and 22) is also different from the rest of the Branchiopods examined. The musculature is much simpler. The most notable feature is the complete absence of a transverse muscle posterior to the ventral adductor muscle.

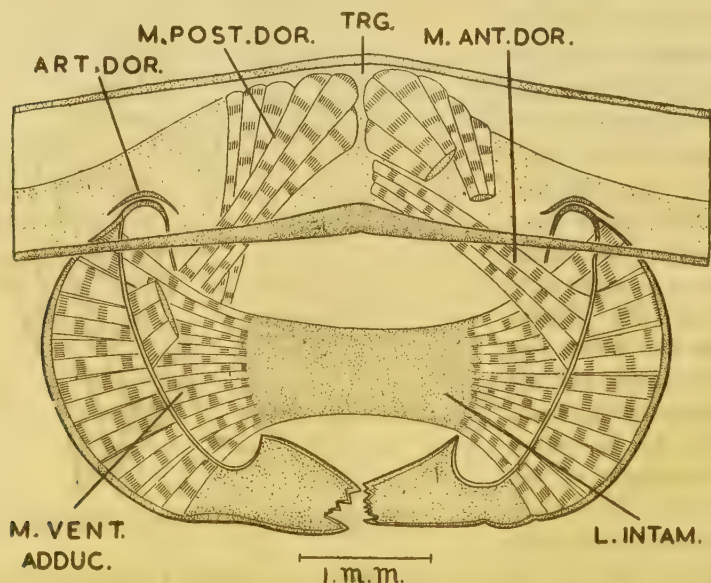


Fig. 21. (Reconstruction showing musculature).

The ventral adductor (M. VENT. ADDUC.) is, however, enormously developed and completely fills the cavity of the coxale cup. The intermandibular ligament (L. INTAM.) is a thick plate, narrow in the middle and expanded into convex margins at the sides. Its anterior and posterior margins are slightly curved downwards, while the muscles from the coxale cup are attached to the raised lateral margins. The suspensory ligaments are also absent. The anterior dorsal muscle (M. ANT. DOR.), although it has a broad area of attachment on the anterior margin of the cup, runs obliquely upwards and slightly backwards to be attached dorsally near the middle line. The posterior dorsal muscle (M. POST. DOR.) is much longer than the anterior, although Snodgrass (1950; Fig. 2C) shows both as equally developed. It is superficially divided into two bands; the anterior runs obliquely upwards and forwards and part of it may overlap the anterior dorsal muscle: the posterior band, although it is in close association with the anterior runs obliquely backwards. In general, the musculature resembles that of *Eubranchipus* (sketched by Snodgrass) with the difference that the suspensory ligaments are absent.

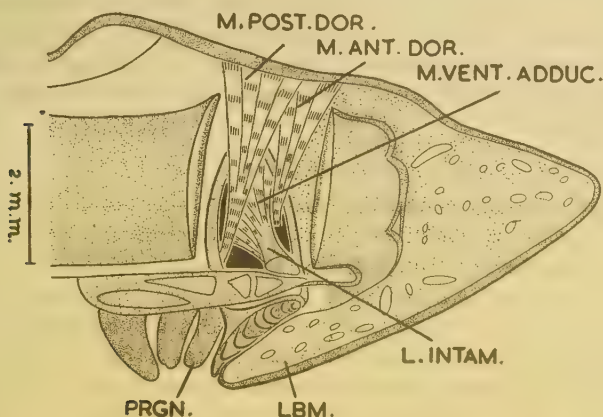


Fig. 22. (Median view—mouth parts and musculature).

The actual movements of the mandibles could not be studied as live material could not be obtained. However, in a fixed specimens the animal was seen holding a part of the antenna of some other crustacean between the mandibles and the maxillules behind it; as if the teeth of the mandibles were about to crush it into small pieces, thereby suggesting that the adduction of the mandibles must be very powerful and likewise the abduction must be possible. How this is brought about is difficult to analyse from the very simple pattern of the musculature. This pattern might be associated

with the general evolution of the limb structure, which Cannon (1933) has shown to have developed separately from the ancestral type; because the animal feeds, apart from filtered food, on large masses. Judging from the general shape, and the angle of attachment of the dorsal muscles and the dorsal articulation, the anterior dorsal muscle will rock the body of the mandible forwards with the result that the gnathal lobe will move outwards, and vice versa, the posterior dorsal will help in the adduction of the gnathal lobe with a much greater force than in abduction. Once the food has been crushed into small pieces it will be pushed up into the oesophagus. For this purpose the upper group of the setae present at the anterior end, because of the inclined nature of the gnathal lobe, will move close to the oesophageal opening. The setae on either side of the dorsal cone of the teeth of the right and of the ventral cone of the teeth of the left are perhaps merely for cleaning purpose.

From the above account it is obvious that the mandibles of *Apus* in their dorsal position of articulation on the body, the structure of the gnathal lobes, and the musculature, are entirely different from all the other Branchiopods described in this work. This is of the greatest significance when it is considered with the structure of the other limbs behind and their comparison with the limbs of the other Branchiopods. As Cannon (1932: p. 332) has shown the structure of the limbs of *Apus* stand quite apart from the structure of the Branchiopod limbs. So is the mandible, different from the others.

DISCUSSION

In the examples studied for the various orders of the class Branchiopoda, *Chirocephalus* (Anostraca); *Lepidocaris* (Lipostraca); *Caenestheria* (Conchostraca) and *Daphnia* (Cladocera) are filter feeders while the *Leptodora* and probably *Bythotrephes* (Cladocera) are reptatory. *Apus* (Notostraca) is peculiar in being both *i.e.*, filter feeder and reptatory. With all these differences in the feeding habit, the mandibles are of pendant type, having a condyler head, articulating with a definite articular surface, which is a thickening of the exoskeleton. When it is dorso-lateral in position (*Chirocephalus*), it is formed on the tergum (Fig. 1) and when dorsal as in *Apus* (Fig. 21) it is on the undersurface of the carapace. Intermediate condition is perhaps shown by *Caenestheria* (Fig. 7) where the tergum of the mandibular segment is raised on the lateral side, and the condyler heads of the mandibles have no cone-like projections and fit almost under it. This single articulation (dorsal or dorso-lateral) regardless of its position will allow free movement of the mandibles in any direction.

The most characteristic feature of the Branchiopod mandible, however, is the complete absence of the palp in the adult stage (Calman, 1909). In

larval stages, as seen in the Nauplii of *Artemia*, it is clearly biramous and aids in the swimming. "Borradaile (1926) describes a small rudiment of the palp in the adult of *Polyartemia*, but assign no function to it. It is rather difficult to picture it as assisting the other mouth parts in dealing with the food. Most probably it is sensory in function.

Gnathal lobe, also, shows a characteristic Branchiopod feature and excepting *Bythotrephes*, there being no distinction into an incisor and a molar processes. The structure and armature of the so-called an incisor and a molar process of *Bythotrephes* (Fig. 15) is so different (especially of molar process) that they cannot be compared with the incisor and molar processes of the Malacostracan mandible. It might be that this distinction is peculiar to this animal, to satisfy the particular need of the animal. The animal being planktonic, perhaps it preys upon other animals for its food. Unless more details of this animal are known, it is difficult to decide about homologies at this stage. The gnathal lobe in the majority of the forms is a short stumpy portion, modified according to the feeding habits of the animal. In the true filter feeding form, like *Caenestheria* and *Daphnia*, the gnathal lobes are used for masticating the food, as well as for transferring it towards the mouth. For this the gnathal lobes, of both right and left, have masticatory surfaces. The masticatory surface of the left gnathal lobe in these forms overlaps the right (Figs. 10 and 13). The masticatory surfaces have transverse ridges made up of spines. The arrangement and number of transverse ridges of the two surfaces is different. With the rocking of the mandibles, the masticatory surface work against each other and this is an efficient way for grinding the food. The food is pushed towards the mouth by the general sweeping action of the masticatory surfaces as in *Caenestheria* and when the right is only moving *Daphnia*, it is aided by a single large tooth present on the posterior margin.

In *Chirocephalus*, which is chiefly a filter feeder (Cannon, 1928) but sometimes feed on large food particles (Cannon, 1933; 1937 and Lowndes, 1933), the masticatory surface instead of overlapping, face each other in the mid ventral line (Fig. 4). This opposing position is especially useful in gripping and biting the large food particles. The row of eight teeth on the dorsal margin of the masticatory surface of the left gnathal lobe and the one at the posterior margin of the right are probably an adaptation in this direction. The food, however, is pushed forward, towards the mouth by a row of anterior marginal spines.

In *Apus*, which feeds on large food masses, both filtered and picked up directly, the gnathal lobes are dorso-ventrally flattened. They are at right angles to the longitudinal axis of the body and inclined antero-posteriorly. The gnathal margin (Fig. 19) is provided with eight teeth and at the anterior

margin there is bunch of small setae on a short protuberance. Crampton (1921) suggests that the tooth area might represent the incisor process and the short protuberance with a bunch of small setae as the reduced molar process of the mandible of Malacostraca. Borradaile (1917), however, compares the biting surface of the mandible of Notostraca (*Apus*) with the dorsal row of transverse ridges on the masticatory surface of the mandible of *Chirocephalus*. But a close comparison with *Chirocephalus* suggests that the teeth on the gnathal margin of *Apus*, correspond with the eight teeth, found on the dorsal margin of the masticatory surface of left mandible of *Chirocephalus* and the short protuberance with small setae representing as the reduced masticatory surface. The teeth crush the food and the small spines helps in pushing the food towards the mouth.

The gnathal lobes in *Leptodora* (Fig. 14), which is purely a reptatory form, are of entirely different character and in no way correspond with those of either Branchiopoda or Malacostraca. They are very long and are provided with four teeth on their inner margins.

In musculature all the forms whether filter feeder or reptatory, have an anterior dorsal, a posterior dorsal from the anterior and posterior walls of the mandibular cup, and attached to the dorsal body wall, rocking the mandibles both forwards and backwards. The mandibles are held together by a large ventral adductor muscle with an intermandibular ligament. In addition to this there is the posterior transverse muscle with or without a median ligament.

The anterior dorsal is always a single muscle band. The posterior dorsal is generally well developed and is usually single, excepting in *Apus* (Fig. 21), where near the dorsal body wall, it is superficially divided into two, a median and lateral bands. In *Bythotrphe* apart from the division of the gnathal lobe into an incisor and a molar processes, the posterior dorsal muscle is tendinous near its attachment with the mandible (Fig. 16). This is a feature, characteristic of the posterior dorsal muscle in the mandibles of higher Malacostraca (Snodgrass, 1950). Here perhaps it has been acquired independently.

The ventral adductor according to Snodgrass (1950) is formed from the combined ventral muscles-ventral promotor and remotor of the generalised Arthropod limb. This conclusion is perhaps due to the fact that he could not differentiate the posterior transverse muscle from the well-developed ventral adductor muscle. In all the examples studied for this work there is a posterior transverse muscle. It sometimes has a median ligament as in the reptatory form like *Leptodora* (Fig. 14). In the true filter feeding forms it is without any median ligament. In *Chirocephalus*, which is primarily a

filter feeder, a narrow median ligament is present (Fig. 4) because as said above, the animal can also feed on large food particles. In all these examples the bands of the posterior transverse muscle are limited to the posterior wall of the cup of the mandible, and morphologically they occupy the same position as the ventral remotor described by Snodgrass (1950; p. 2 and p. 4; Fig. I A). It is therefore concluded that the posterior transverse muscle with or without median ligament is homologous to the ventral remotor.

The comparative study of the ventral adductor is very interesting, because it shows a great variation in structure in different members depending upon the feeding habit of the animal. In all the filter feeding forms, it is well developed and its fibres appear to fill the cup of the mandibles. If the mandibles are examined from the side view, bands of this muscle have not been seen attached to the posterior wall of the cup. In reptatory forms like *Leptodora* (Fig. 14), the ventral adductor exactly resembles the posterior transverse muscle. Its bands are limited only to the anterior wall of the cup, with a ligament in the centre. Thus morphologically it occupies the same position as the ventral promotor described by Snodgrass (1950) for the generalised Arthropod limb. In the *Apus*, the posterior transverse muscle is absent and ventral adductor is well developed. This adaptation in which only ventral adductor is present, is peculiar to this animal among the examples studied for the Branchiopoda.

The intermandibular ligament of the ventral adductor, muscle in the filter feeding forms is very broad and has two suspensory ligaments, one on each side. In reptatory forms like *Leptodora* (Fig. 14), it is as narrow as the median ligament of the posterior transverse muscle. The origin of the intermandibular ligament in all these forms may be the same as described by S. M. Manton (1928, 1934) in *Hemimysis* and *Nebalia*. She points out that the ectoderm of the intersegmental fold first form the antenno-mandibular bar and that the part of the mesoderm destined to give rise to ventral adductor, comes in contact with this bar. This later becomes separated and forms the intermandibular ligament. The formation of the posterior transverse muscle with or without a median ligament is, however, not described by any author. It might be, that part of the mandibular mesoderm giving rise to this muscle, instead of joining the antenno-mandibular bar, may become continuous. Alternatively part of the antenno-mandibular bar may be lost secondarily. *Chirocephalus* is an example, which being a filter feeder, still retains it.

The only muscle not described so far, is the upper transverse muscle (*Daphnia* and *Bythotrephes*), found dorsal to the posterior transverse muscle and attached to the bases of the posterior dorsal muscles, on each side.

This might develop from that part of the mesoderm of the mandibular segment, which normally forms the posterior transverse muscle, in this case shifted up to a position between the bases of the posterior dorsal, muscles and attached to them. Or it might be that some of the muscles of the posterior dorsal bands converge medially and become continuous in the middle. In all respects, it appears to be a secondary formation, which is not a part of the normal musculature of the mandible.

Concluding, it is possible to picture a generalised plan for the mandibles in Branchiopoda, even though they are widely different from each other and also show a great variation. In this generalized plan, the mandibles would be of pendant type with single dorso-lateral articulation and without any palp in the adult. Gnathal lobes of the type approaching *Chirocephalus* i.e., short stumpy with masticatory surfaces facing each other in the mid ventral line. In musculature there would be an anterior dorsal, a posterior dorsal and ventral abductor muscle with a median intermandibular ligament. The posterior transverse muscle would also be present with or without a median ligament. From such a generalized plan, adaptations towards the filter feeding forms would be the great development of the ventral adductor muscle and the suspension of the intermandibular ligament with suspensory ligaments. Posterior transverse muscle being continuous from mandible to mandible, without any median ligament. Closely approaching to such a plan are perhaps the mandibles of *Artemia* and *Branchipus* (not described). Then in the filter feeding forms, like *Caenestheria* and *Daphnia*, with the overlapping of the masticatory surfaces, there was the development of upper transverse muscle. *Chirocephalus*, being not purely filter feeder, has a median ligament in the posterior transverse muscle, though closely related to *Artemia* and *Branchipus*.

In reptatory forms the gnathal lobes acquire teeth and spines. In musculature, the ventral adductor is not so well developed. The inter mandibular ligament has no suspensory ligaments. The posterior transverse muscle also acquires a median ligament. Except the structure and the shape of the gnathal lobe, the mandibles of *Leptodora* and especially its musculature is very close to this plan. About *Bythotrephes* nothing could be said with certainty as yet. Its gnathal lobes are modified for cutting and tearing purpose, whereas the musculature resembles *Daphnia* which is a pure filter feeding form. The only indication in the musculature of its being reptatory in nature, is the tendinous nature of the posterior dorsal muscle. It is rather difficult to correlate these two features unless more information is available regarding its food and feeding habits.

Apus yet is another example, which though showing adaptations of

its own, is still close to the generalised plan. Its gnathal armature is homologous with upper row of teeth on the masticatory surface of the left gnathal lobe in *Chirocephalus*, and small protuberance with short spines represents the reduced masticatory surface. Posterior transverse muscle is entirely lost. Anterior adductor is enormously developed, but the intermandibular ligament is without any suspensory ligament. Its dorsal articulation as has been shown above, is perhaps a modification of the original dorso-lateral articulation. All these characters suggest that *Apus* mandibles have been derived primarily from the filter feeding generalised pattern, probably through reduction.

SUMMARY

1. The mandibles have condylar head-like portion, which articulates on the lateral side of the body with the articular surface. This articulation is, however, dorsal in *Apus* (Notostraca). This single articulation, regardless of its position, allow free forward and backward movement of the mandibles about a fixed point.

2. In the majority of the Branchiopoda, especially the filter feeders, the gnathal lobe is short stumpy structure provided with transverse ridges, made up of spines of various types. The chief function is to grind the food and to push it forward towards the mouth. In reptatory forms, however, the gnathal lobe has no grinding surface, instead it acquires various shapes and is provided with sharp teeth.

3. In musculature the anterior dorsal is a single band, posterior dorsal is also a single but generally well-developed as compared with the anterior dorsal.

4. In all the filter feeding Branchiopoda, the ventral adductor muscle is well developed and its fibres fill the cup of the mandible. The intermandibular ligament to which the fibers are attached in the middle, is very broad and has two suspensory ligaments, one on each side. In reptatory forms, the intermandibular ligament is very narrow and there are no suspensory ligaments.

5. The posterior transverse muscle is present in all excepting *Apus* (Notostraca). In reptatory forms, it is provided with a very narrow median ligament in the middle, in the filter feeding forms, however, it is without any median ligament and is continuous from mandible to mandible.

6. In addition to the posterior transverse muscle, an upper transverse muscle has been described in *Daphnia*, *Bythotrephes* (Cladocera).

7. The homologies of the various muscles and the possible working of the mandible with its functional adaptation correlated with the feeding habit within the Branchiopoda has been discussed,

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Preliminary studies on the genetics of *Tolyposporium penicillariae* Brefeld

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Genetics of many species of the smut fungi has been investigated and the available information has been reviewed by Christensen and Rodenhiser (1940) and Holton (1933). However, little information is available on the genetics of *Tolyposporium* smuts.

The present investigation was taken up to provide information on the genetics of *Tolyposporium penicillariae* Bref. occurring on *Pennisetum typhoides*. This smut occurs commonly in Pakistan and presented readily available material for a study of the genetics of the smut. Studies on the artificial culture of the smut and its nutritional requirements as related to genetics were also included in the study.

MATERIAL AND METHOD

The chlamydospore material of *Tolyposporium penicillariae* used in this study was collected from Jhelum District. Four monosporidial isolates arising from single chlamydospore were isolated for this study.

The single chlamydospores and sporidia were isolated by following a slight modification of the method described by Dickinson (1933) and Hanna (1928). The chlamydospores of the smut were presoaked for about 24 hours in distilled water to facilitate germination. The single chlamydospores were allowed to germinate and four sporidia arising on the promycelium were isolated and were transferred to individual potato-dextrose agar slants. The isolates were maintained on potato-dextrose agar. Each chlamydospore was given a number in letters and the sporidia were given arabic number according to their position on the promycelium starting from the apex downward. Thus, sporidia from chlamydospore A were designated A1, A2, A3 and A4 according to the position of the sporidia.

Natural and synthetic media were used in this study. The natural medium most commonly used was potato-dextrose agar. For nutritional studies, the basal medium was used. The basal medium and other synthetic media used in this study had the following composition:

Basal medium: dextrose, 20 gm.; potassium dihydrogen phosphate, 1.5 gm.; magnesium sulphate, 0.5 gm.; potassium nitrate, 3.12 gm.; agar, 15 gm.; and distilled water to make up 1000 ml.

Glucose nutrient agar: glucose, 20 gm.; peptone, 10 gm.; sodium chloride, 5 gm.; beef extract, 4 gm.; and distilled water to make up 1000 ml.

Glucose peptone agar: glucose, 10 gm.; peptone, 20 gm.; potassium dihydrogen, 1 gm.; magnesium sulphate, 0.5 gm.; agar, 30 gm.; and distilled water to make up 1000 ml.

Except when otherwise stated, all cultural studies were made at 30°C and at least in quadruplicate. The sexual reactions of monosporidial isolates were determined by the Bauch test (Bauch, 1922, 1932), sporidial fusions and finally by the production of chlamydospores.

CULTURAL VARIATION IN ISOLATES

Culture media.

The growth and cultural characters of the four monosporidial isolates were studied on four culture media: basal medium, potato-dextrose agar, glucose nutrient agar and peptone nutrient agar. The isolates were grown on these culture media in four replications and were incubated at 30°C. for 14 days.

The four monosporidial isolates differed in one or more of the following characters: colony diameter, colour, luster, consistency, surface and topography. The four culture media generally affected the cultural characters of the monosporidial isolates of the smut. In general, the four monosporidial isolates fell into two cultural groups. Isolates 1 and 3 belonged to one group and isolates 2 and 4 to the other. The cultural characters of the monosporidial isolates on four cultural media are presented in Figure 1.

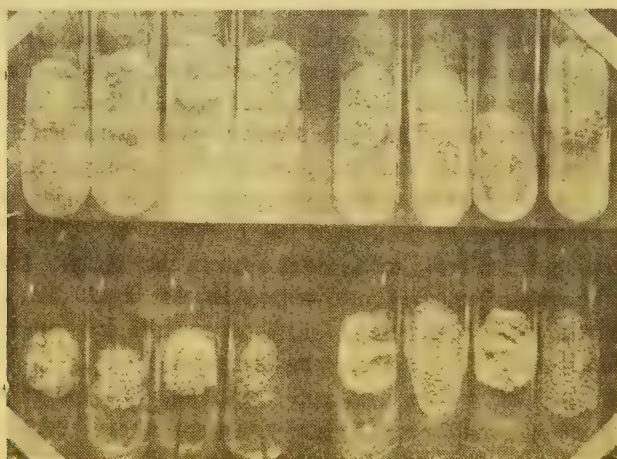


Figure 1: Cultural characters of four monosporidial isolates of *Tolyposporium penicillariae* on four cultural media after fourteen days. Upper row from left to right: isolates 1, 2, 3 and 4 on basal medium and on potato-dextrose agar. Lower row from left to right: isolates 1, 2, 3 and 4 on glucose nutrient agar and on glucose peptone agar.

Temperature.

Growth and cultural characters of four monosporidial isolates were studied on the basal medium at different temperatures. The monosporidial isolates were grown singly on the basal medium in four replications and were incubated at 20, 25, 30 and 35°C. The colony diameters attained by the monosporidial isolates were recorded after 14 days and are presented in Figure 2.

The monosporidial isolates 1 and 3 did not grow at all at 35°C., but isolates 2 and 4 did so poorly. However, the maximum growth of all the isolates was at

30°C. The four monosporidial isolates formed two groups over the range of temperatures studied. Isolates 1 and 3 belonged to one group and grew faster than the isolates 2 and 4 of the second group at 20, 25 and 30°C. The cultural characters of monosporidial isolates were not appreciably affected at the temperatures studied. However, cultural differences among the isolates including those of colour, elevation, lustre, consistency, surface and topography were more or less maintained.

Hydrogen-ion concentration.

The effect of hydrogen-ion concentration of the culture medium on the growth and cultural characters of four monosporidial isolates was studied on the basal medium.

The basal medium was adjusted to a pH of 3.4, 3.9, 4.5, 5.4, 6.2, 7.2, and 8.2. The pH ranges 3.4 to 5.4 and 7.2 to 8.2 were adjusted with the addition of N/20 hydrochloric acid and 2 per cent sodium hydroxide respectively to the basal medium. In a preliminary trial, the quantities of N/20 hydrochloric acid and 2 per cent sodium hydroxide required to give the desired pH values were determined. In actual experiment, the medium and acid and alkali were sterilized separately and were combined later. The pH values of these combined solutions represented the initial pH values in each case. Colony diameters and cultural characters of isolates were recorded after 14 days. At the time of final observations, the final pH of the medium was determined to study the shift in pH of the medium as a result of the growth of the isolates.

The colony diameter attained by the monosporidial isolates summarized graphically in Figure 3 indicated different optima of pH values of the medium

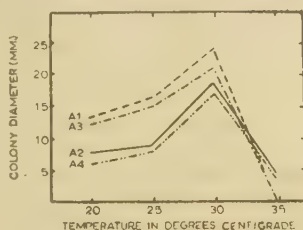


Figure 2: Effect of temperature on the colony diameter of four monosporidial isolates of *Tolyposporium penicillariae* on the basal medium after fourteen days.

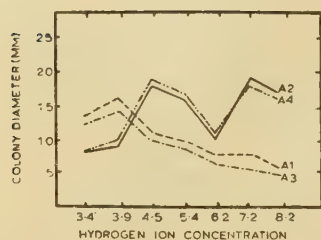


Figure 3 : Effect of initial pH of the basal medium on the colony diameter of four monosporial isolate of *Tolyposporium penicillariae* after fourteen days.

the pH of the medium. In general, there was a tendency for the pH on the acid side to increase and that on alkaline side to decrease by growth of the smut.

NUTRITIONAL REQUIREMENTS

Importance of nitrogen and carbon source.

The nutritional requirements of the four monosporial isolates for growth in culture were studied on the basal medium. The relative importance of the carbohydrate and the nitrogen component was assessed by growing four monosporial isolates on the complete basal medium and the basal medium lacking in potassium nitrate and the basal medium minus glucose at 30°C. in four replications. The colony diameter of the monosporial isolates attained after 14 days on the media summarized in Table I indicated that the growth of all the isolates was sparse on the

TABLE I

Colony diameter of the monosporial isolates of *Tolyposporium penicillariae* on the basal medium with and without nitrogen and carbohydrate sources after fourteen days.

COLONY DIAMETER (MM.) OF THE ISOLATES ON				
Isolate	Basal medium	Basal medium lacking in nitrogen source	Basal medium lacking in carbohydrate source	
A1	24	15	18	...
A2	14	9	12	...
A3	26	18	20	...
A4	12	7	11	...

basal medium lacking in nitrogen and glucose. The colony diameter and type of growth suggested that the carbohydrate and the nitrogen sources were both important for the growth of the fungus in culture. However, four monosporidial isolates formed two groups on three media used. Monosporidial isolate 1 and 3 comprised one group and the isolates 2 and 4 comprised the other group.

Source of Nitrogen.

The influence of nitrogen source is the medium on the growth of the monosporidial isolates was studied by growing them on the basal medium with different sources of nitrogen at 30°C. Nitrogen was used at the rate of 42 mg. per litre as potassium nitrate, ammonium nitrate, ammonium sulphate, urea, peptone and asparagin. The colony diameter attained by the monosporidial isolates after 14 days, summarized in Table 2, indicated that

TABLE II

Colony diameter of the monosporidial isolates of *Tolyposporium penicillariae* on the basal medium containing six different sources of nitrogen after fourteen days.

Source of nitrogen in the medium	AVERAGE COLONY DIAMETER (MM.) ATTAINED BY ISOLATES			
	A1	A2	A3	A4
Potassium nitrate ...	13	9	16	7
Ammonium nitrate ...	10	11	12	11
Ammonium sulphate	10	12	11	9
Urea ...	8	8	11	10
Peptone ...	14	18	14	15
Asparagin ...	11	22	14	18

the colony diameter of the isolates 2 and 4 was the maximum on the basal medium with asparagin as source of nitrogen. However, isolates 1 and 3 produced highest colony diameter on the medium with potassium nitrate as nitrogen source followed by that with peptone. Thus, the four monosporidial isolates comprised two groups with specific nitrogen requirements for their growth on solid culture media. This grouping was particularly marked on the medium with asparagin and potassium nitrate as the sources of nitrogen.

Quantity of Asparagin.

The response of the four monosporidial isolates to different quantities of asparagin in the basal medium was studied by using asparagin at the rate of 0.94, 1.88, 3.76 and 7.52 gms. per litre. The basal medium without asparagin served as check. The colony diameter of the isolates as affected by the quantity of asparagin after 14 days at 30°C. is presented graphically in Figure 4.

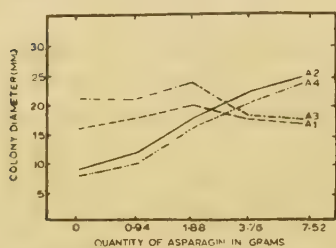


Figure 4.—Effect of different quantities of asparagin in the basal medium on the colony diameter of four monosporidial isolates of *Tolyposporium penicillariae* at 30°C. after fourteen days.

not increase with higher rates of asparagin as was the case with isolates 2 and 4. The cultural characters of the monosporidial isolates of the smut were not affected appreciably by the rates of asparagin used in the basal medium.

Source of carbohydrate.

The influence of carbohydrate source on the colony diameter of the monosporidial isolates was studied by growing them on the basal medium containing glucose, sucrose, maltose, starch or lactose as the carbohydrate source. The colony diameter attained by the isolates on the basal medium with different sources of carbohydrates at 30°C. after 14 days are summarized in Table 3.

TABLE III

Colony diameter of the monosporidial isolates of *Tolyposporium penicillariae* on the basal medium containing five different sources of carbohydrates after fourteen days.

Source of carbohydrate in the medium	AVERAGE COLONY DIAMETER (MM.) ATTAINED BY ISOLATES			
	A1	A2	A3	A4
Glucose	13	17	28	11
Sucrose	19	20	31	12
Maltose	13	14	25	11
Starch	11	12	24	8
Lactose	21	14	31	10

The four monosporidial isolates generally grew better on the basal medium with sucrose as source of carbon. Monosporidial isolates 1 and 3 attained the same colony diameter on the medium with lactose as on the medium with sucrose, but the growth in the former case was very sparse and thin.

The cultural characters of the monosporidial isolates were not affected to any appreciable extent by the source of carbohydrate in the basal medium.

Quantity of sucrose.

Different quantities of sucrose used in the basal medium to study their influence on the growth and other cultural characters of four monosporidial isolates were incubated on the medium at 30°C. for 14 days. The colony diameter attained by the isolates are summarized graphically in Figure 5.

Higher rates of sucrose were helpful for better growth of the monosporidial isolates which was reflected more in the aerial mycelium than in the colony diameter. The monosporidial isolates 1 and 3 grew better on the medium with different quantities of sucrose than the isolates 2 and 4. The monosporidial isolates fell into two groups on the medium with different quantity of sucrose.

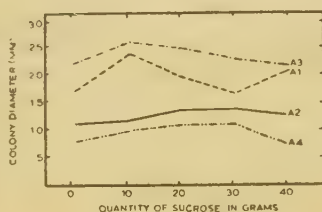


Figure 5: Effect of different quantities of sucrose in the basal medium on the colony diameter of four monosporidial isolates of *Tolyposporium penicillariae* at 30°C. after fourteen days.

The cultural characters of the four monosporidial isolates were not affected significantly by different quantities of sucrose used in the basal medium.

EVIDENCE OF HETEROTHALLISM

No information is available whether *Tolyposporium penicillariae* is heterothallic. As infection in heterothallic smut fungi takes place by paired monosporidial lines of opposite sex, a study of the sexual compatibility of the monosporidial isolates was taken up. Results of preliminary experiments showed that infection of *Pennisetum typhoides* ears did not result from monosporidial isolates singly. Further evidence of heterothallism in the smut was tested by Bauch test and production of chlamdospores on the inoculated plants.

The Bauch test was used successfully for determining the sex compatibilities of monosporidial lines of *Ustilago violaceae*, *Ustilago zaeae* and *Ustilago scorzoneriae* (Bauch, 1922, 1932) and consisted of growing the paired monosporidial lines on slightly alkaline three per cent malt agar. According to Bauch (1922, 1932), the resulting growth of the two compatible lines form a white mycelial mat over the culture of compatible lines different from those of incompatible lines.

Monosporidial isolates of *Tolyposporium penicillariae* from the same promycelium were grown on three per cent alkaline malt agar singly and in all possible paired combinations. The growth from certain paired monosporidial isolates formed white mycelial mat showing their compatibilities. The result of Bauch test summarised in Table 4 showed that monosporidial isolates 1 and 3 belonged to one sex and isolates 2 and 4 belonged to the opposite sex.

TABLE IV

Results of pairing monosporidial isolates of
Tolyposporium penicillariae on Bauch's medium.

	A1	A2	A3	A4
A1 ...	-	+	-	+
A2 ...	+	-	+	-
A3 ...	-	+	-	+
A4 ...	+	-	+	-

In an effort to produce chlamydospores of the smut, ears of *Pennisetum typhoides* were inoculated with monosporidial isolates and their paired combination. Inoculations were made by infecting the flowers in the ear following Bhatt (1946). No infection resulted from either the monosporidial isolates or from the possible paired combinations under the conditions of the experiment. It was not, therefore, possible to confirm the results of compatibility of monosporidial isolates as determined by Bauch test. However, the compatibility of the monosporidial isolates as determined by Bauch test was further tested by the fusion of sporidia of the compatible isolates. Fusion of sporidia was observed only in paired cultures of the monosporidial isolates found compatible in the Bauch test.

The results of these tests indicate that *Tolyposporium penicillariae* is heterothallic and segregation of factors for sex took place in 2:2 ratio in the chlamydospore investigated.

DISCUSSION

Tolyposporium penicillariae like most of the smut fungi appears to be heterothallic. The results of Bauch test and sporidia fusion among the compatible isolates agreed substantially and indicated heterothallic nature of the smut.

Segregation of factors for sex and cultural characters was studied in four monosporidial isolates arising from one chlamydospore. The factors for sex segregated in the ratio of 2:2, indicating the existence of two sex groups. The behaviour of sex groups among the four monosporial isolates suggested segregation for sex in second division of the fusion nucleus.

Similarly, four sporidial isolates from single chlamydospore studied on four culture media showed that factors for cultural characters including colony diameter segregated in the ratio of 2:2 and that segregation of factors for cultural characters took place in the same division of the fusion nucleus as the segregation of factors for sex. In the limited number of sporidial lines investigated, evidence of segregation of factors for cultural characters independent of segregation of factors for sex as reported in many smuts was not available (Christensen and Rodenhiser, 1940; Holton, 1953).

Likewise, the four monosporidial isolates comprised two cultural groups for their colony diameter and cultural characters on the basal medium at different temperatures and pH values of the medium. This was also true, generally, on the basal medium with different sources of nitrogen and carbon and different quantities of nitrogen and carbon sources. The grouping of the isolates into cultural types was particularly obvious on the basal medium with potassium nitrate or asparagin as the nitrogen source and on the series of the same medium containing different quantities of asparagin.

As *Tolyposporium penicillariae* has been indicated to be heterothallic and the sori of the smut group themselves in clusters theoretically, there would seem to be more opportunity for recombinations from compatible sporidia arising from different chlamydospores than in other smuts. The recombination of different characters can, therefore, take place more readily in the *Tolyposporium* smut than in smuts belonging to *Ustilago* and *Sphacelotheca*. This would suggest a greater variation in *Tolyposporium* smuts than in smuts belonging to *Ustilago* and *Sphacelotheca*. Whether this is true has not been determined definitely.

Further investigations on the variation in *Tolyposporium* smuts vs

compared to variation in smuts of the genus *Ustilago* and *Sphacelotheca*, and induced variation through hybridization should prove interesting and should add to the information on variation in the smut fungi.

SUMMARY

The four monosporidial isolates from a single chlamydospore of *Tolyposporium penicillariae* comprised two distinct groups as regards their colony diameter and cultural characters on four culture media, at different temperatures and over the pH range 3.4 to 8.2 of the basal medium.

The four monosporidial isolates grew well over the range of temperature from 20 to 30°C., with maximum growth in terms of colony diameter at 30°C. Two monosporidial isolates did not grow at 35°C., whereas the other two did so poorly.

Monosporidial isolates of the smut grew well over range of pH 3.4 to 8.2 of the basal medium. The four monosporidial isolates has different optima for their growth on the basal medium.

The nitrogen and carbohydrate components of the basal medium were almost equally important for the growth of the monosporidial isolates of the smut. Of the sources of nitrogen investigated in the basal medium, asparagin proved the best for two isolates and potassium nitrate for the other two. The colony diameter of two isolates increased with an increase in the quantity of asparagin in the medium, whereas the other two isolates did not respond to higher quantities of asparagin.

Of the sources of carbohydrates used in the basal medium, sucrose was the best for the growth of all the isolates. Two monosporidial isolates grew better on the basal medium with different quantities of sucrose than the other two.

The cultural characters of the individual monosporidial isolates were not affected appreciably by the pH of the basal medium and the temperature at which they were grown. Similarly, carbohydrate and nitrogen sources and their quantities in the basal medium had no marked effect on the cultural characters of the monosporidial isolates.

Bauch test and sporidial fusions indicated heterothallic nature of the smut. Segregation of factors for sex was on 2:2 basis and took place in the second division of the reduction process in one chlamydospore studied.

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Jasmine blight caused by *Cercospora jasminicola* Muller & Chupp.

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Epiphytotics of *Cercospora jasminicola* were observed to cause drying of the hedges of jasmine (*Jasminum officinale* L.) at the Agricultural College, Lyallpur. The disease appears to advance from the lower vines upward, involving the entire hedge in a few days. Almost all the leaves on a vine are affected. The diseased leaves shrivel, dry and are later shed, which gives the dried vines a denuded and charred appearance.

During the initial stages of the attack, the affected leaves show reddish brown to chocolate-coloured spots on leaflets. The spots vary in size from pin point to several millimeters. They are central as well as marginal in location. The margin of the spots are somewhat darker in colour and irregular to round in outline. On the lower surface of the leaflets, the spots are dull brown to ashy in colour and exhibit an effuse growth of the fungus. Several spots on a leaflet coalesce to form bigger spots. Leaf petioles have also been observed to bear lesions of the disease.

After the affected leaves have fallen, the disease appears to attack the branches which are also killed. Lesions of the disease have not been observed on the flowers so far.

Microscopic examination of the spots on the affected leaves has revealed the presence of profuse mycelial growth of the species of *Cercospora* bearing heavy crop of conidia. The fungus was studied in detail and is described below:

Conidiophores in dense fascicles, pale to pale brown, tip almost hyaline, septa inconspicuous, rarely geniculate, not branched, straight to curved, tip bluntly rounded, $2-4.35 \times 10-25\mu$. *Conidia* pale to pale olivaceous, obclavate-cylindric, indistinctly septate, septa up to nine, straight to slightly curved, base obconically truncate, tip subobtuse, $2-4.27 \times 25-110\mu$.

The fungus has already been reported and described by Chupp (1953) and has also been recorded by Ahmad (1956) from West Pakistan. Chupp (1953) has listed several species of *Jasminum* as the hosts of the fungus. Ahmad (1956) did not mention the species of *Jasminum* from which the fungus was collected. In view of the close identity of the morphology of the fungus found at Lyallpur on *Jasminum officinale* L. with the one described by Chupp, it is concluded that the fungus reported here is *Cercospora jasminicola* Muller and Chupp.

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Cotton as New Pycnidial Host of *Macrophomina phaseoli*

(Maubl.) Ash. (*Sclerotium bataticola* Taub.)

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The pycnidia of *Macrophomina phaseoli* (Maubl.) Ashby recently renamed as *Botryodiplodia phaseoli* (Maubl.) Thirumalachar (1953) have been reported to occur naturally on diseased stems of sesamum (Small, 1927), Jute (Mc Rae, 1922), French beans (Luttrell, 1946), stems of potato and water-melon (Young, 1949), and on kernels of maize, sun-hemp, jute and stems of potato (Thirumalachar, 1953). The pycnidial stage of the fungus does not appear to have been reported on cotton, whereas the sclerotial stage occurs commonly (Vasudeva, 1935, Sattar, 1952). The present paper reports the pycnidial stage occurring naturally on cotton leaves and presents a study of the pycnidial stage on cotton leaves.

OCCURRENCE OF THE PYCNIDIAL STAGE ON COTTON LEAVES

In a field experiment on root of cotton laid out at Lyallpur, the cotton plants showed drying up of the cotyledonous leaves. The crop was sown rather late in the season and after the germination of cotton seed was over, there was more or less a continuous spell of intermittent rains, resulting in a little lower temperature and higher humidity.

Most of the cotton plants showed severe shrivelling of the cotyledonous leaves. Drying of the leaves started from the margins and progressed towards the petiole. In advanced cases, the total surface of the cotyledonous leaves was involved. The colour of the dead areas appeared slightly pinkish and water-soaked in the beginning. Later, the dead portions tended to shrivel and showed the development of pycnidia of the fungus as black pin-points.

The disease appeared as a mild epiphytotic and the pycnidia developed on a number of leaves. On examination under the microscope, typical pycnidia and pycnospores of *Macrophomina phaseoli* (= *Botryodiplodia phaseoli*) were visible.

THE FUNGUS IN CULTURE

Aqueous suspension of the pycnospores was prepared and the fungus was cultured by the dilution plate method. The germinating pycnospores were picked and transferred to 2 per cent potato-dextrose agar slants which

were incubated at room temperature for about a week. Isolations were also made from the dead leaves of cotton showing no fruiting bodies as well as from those with fruiting bodies. After three or four days' incubation at room temperature, the fungus grew vigorously on the agar slants and developed numerous, minute, black, typical sclerotia of *Sclerotium bataticola* in about a week. The cultures were not disturbed for about 15 days, in the hope that the pycnidia of the fungus might develop, but microscopic examination indicated that only sclerotia developed. Sixty monoconidial isolates of the fungus were studied. All of them resembled one another and constituted pure cultures of *Sclerotium bataticola*. All of them developed sclerotia on potato-dextrose agar and pycnidia did not develop from any of them. It was concluded that the pycnospores giving rise to pure culture of *Sclerotium bataticola* and the pycnidia found on the dead portions of primary leaves of cotton belong to *Macrophomina phaseoli* (Maubl.) Ashby [= *Botryodiplodia phaseoli* (Maubl.) Thirumalachar].

CHARACTERS OF PYCNIDIA, PYCNOSPORES AND SCLEROTIA

The characters of the pycnidia of the fungus on cotton leaves, pycnospores from the pycnidia and the sclerotia developed from pycnospores on potato-dextrose agar were studied and are summarised:

Pycnidia: maculicole, bifrons, globose to subglobose, more or less stromate, separate, glabrous, membranous to sun-carbonous, average diameter $127.9\ \mu$, not beaked, ostiolate; ostiole $13.3\ \mu$, dark, with broken edges; pycnospores hyaline, continuous, oblong to elliptical, bluntly rounded at both ends, $11.1\text{--}25.9 \times 7.0\text{--}8.4\ \mu$, averaging $19.3 \times 7.4\ \mu$.

Sclerotia: minute, black, without fibrils, irregularly shaped, hard, on breaking release numerous oil-like drops, size ranged between $39.9\text{--}173.2 \times 39.9\text{--}119.9\ \mu$, with an average of $103.9 \times 74.5\ \mu$. According to Haig (1930) the sclerotial form falls under strain 'C'.

DISCUSSION

The sclerotial stage of *Macrophomina phaseoli* (Maubl.) Ashby occurs commonly on cotton roots and has been considered the cause of root rot in West Pakistan by Vasudeva (1935). The pycnidial stage of the fungus does not appear to have been reported on cotton and the present report apparently is the first in this respect.

Sattar (1952) inoculated *Sesamum indicum*, *Arachis hypogaea*, *Citrus aurantium*, *Gossypium herbaceum* and *Hibiscus esculentus* with the sclerotia of *Sclerotium bataticola* from cotton roots and other host plants. He found that the isolates including that from cotton were strongly pathogenic on

Sesamum indicum, *Citrus aurantium* and *Arachis hypogaea* and developed pycnidia on Sesamum plants only. Cotton plants were not infected and did not develop pycnidia of the fungus. Similarly, Thirumalachar (1953) reported the formation of pycnidial stage of the fungus on inoculated potato stems at 28°-35°C. from the sclerotial isolates of the fungus from jute, sun-hemp, maize, garlic, castor and *Solanum nigrum*.

Luttrell (1946) described a pycnidial strain of the fungus, which developed pycnidia on three per cent malt agar. He also described the development of pycnidia on inoculated sterilized snap-bean stems soaked in water by many sclerotial isolates of the fungus from sixteen different hosts. Similarly, Thirumalachar (1953) reported the pycnidial stage in artificial culture by one of the isolates from maize on potato-dextrose agar.

The measurements of the pycnospores of the fungus on cotton leaves being reported agreed substantially with those given for the fungus by Luttrell (1946), Sattar (1952) and Thirumalachar (1954). Further studies on pycnidial stage of the fungus isolated from diseased cotyledons of cotton and that produced artificially on the stems of Sesamum are in progress. The diseased plant specimens have been deposited in the Mycological Herbarium of the Division of Plant Pathology, Agricultural College and Research Institute, Lyallpur.

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Revision of the Species of the Genus *Pestalotia* de Not. in Pakistan

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The genus *Pestalotia* was established by de Notaris (1839) to accommodate a new species on dead vines of *Vitis vinifera*, with fruiting structure resembling the outline of an apothecium. The type species was appropriately named as *Pestalotia pezizoides* by de Notaris.

Subsequent to the establishment of the genus, many new species were added to the genus which have four, five and six celled conidia and different number of setae. Saccardo (1884) subdivided the genus in three subgenera; *Eupestalozzia* conidia with hyaline end cells, coloured median cells and two or more apiculate setae), *Monochaetia* (unisetulate conidia), and *Pestalozzina* (totally hyaline conidia), Later, the sub-genera *Pestalozzina* and *Monochaetia* were raised to generic ranks by Saccardo (1895) and Allescher (1902) respectively. Thus, the genus *Pestalotia* was restricted to the sub-genus *Eupestalozzia* of Saccardo.

Klebahn (1914) further subdivided the genus *Pestalotia* of the restricted sense into sections, *Quadriloculatae* (4 celled conidia), *Quinqueloculatae* (5 celled conidia) and *Sexloculatae* (6 celled conidia) on the basis of the number of conidial cells. This arrangement was followed by Guba (1929, 1932) when he monographed the genus and described and keyed out 73 species of the genus.

Steyaert (1949) studied the type species *Pestalotia pezizoides* de Not. and other species of the genus, and concluded that other species of *Pestalotia* are different from the type species. He found that in the type species,—*P. pezizoides* the conidia are six loculate and not six-celled as rings of globular mass entirely replaces the true septum. He has, therefore, restricted the genus *Pestalotia* de Not. to a single representative *P. pezizoides* de Not. and has also amended the description of the genus *Pestalotia*. In this restricted sense, the genus corresponds to the section *Sexloculatae* of Klebahn represented by only one species. According to Steyaert (1949), *p. pezizoides* de Not. represents an evolutionary type which merits a distinct generic discrimination.

The remaining species have been accommodated in two new genera erected by Steyaert (1949) on the basis of number of septations in the conidia. These new genera *Truncatella* and *Pestalotiopsis* represent respectively *Quadriloculatae* and *Quinqueloculatae* sections of Klebahn. Besides septa-

tions of conidia, these genera differ also in other characters of conidia and conidiophores.

The species of the genus *Pestalotia* de Not. were studied in the Indo-Pakistan sub-continent by Mundkur & Kheswalla (1942) who described 31 species. Out of them five species (*P. mangiferae* P. Henn., *P. leprolegna* Speg., *P. taslimiana* Mundkur & Kheswalla, *P. theae* Sawada and *P. palmarum* Cooke) have been collected from the parts now included in Pakistan. Another two species (*P. longi-aristata* Maubl. and *P. suffocata* Ellis & Ev.) have subsequently been collected from these parts, and *P. funerea* Desm. has been reported by Alimad and Lodhi (1953) raising the total number of representation to eight.

Steyaert (1949) has already transferred *Pestalotia mangiferae* P. Henn., *P. theae* Sawada, *P. funerea* Desm. and *P. palmarum* Cooke to the genus *Pestalotiopsis*. Three of the remaining four species represented in Pakistan, *Pestalotia leprolegna* Speg., *P. taslimiana* Mundkur & Kheswalla, *P. longi-aristata* Maubl. have quadrisepate conidia and would now be assigned to the genus *Pestalotiopsis*. *Pestalotia suffocata* Ellis & Ev. has, however, triseptate conidia and would now be a *Truncatella*. The transfer of these four species to the newly erected genera *Pestalotiopsis* and *Truncatella* does not appear to have been made and is proposed. The synonymies of the eight species represented in Pakistan are presented.

1. ***Pestalotiopsis leprolegna*** (Speg.) Comb. nov. *Pestalotia leprolegna* Speg. Anal. Mus. Nac. Buenos Aires **23** : 119. 1912.
2. ***Pestalotiopsis longi-aristata*** (Maucl.) Comb. nov. *Pestalotia longi-aristata* Mucl. Bull. Soc. Myc. Fr. : 92. 1905.
3. ***Pestalotiopsis taslimiana*** (Mundkur & Kheswalla) Comb. nov. *Pestalotia taslimiana* Mundkur & Kheswalla. Mycologia. **34** : 310. 1942.
4. ***Truncatella suffocata*** (Ellis & Everhart) Comb. nov. *Pestalotia suffocata* Ellis & Ev. Jour. Myc. **2** : 38. 1886.
5. ***Pestalotiopsis funerea*** (Desm.) Steyaert. Bull. Jard. Bot. Brux. **19** : 304. 1949.
Pestalotia funerea Desm. Ann. Sci. Nat. Bot. II. **19** : 335-336. 1843.
Pestalotia conigena Lev. Ann. Sci. Nat. Bot. III. **5** : 285. 1846.
6. ***Pestalotiopsis mangiferae*** (P. Henn.) Steyaert, Bull. Jard. Bot. Brux. **19** : 320. 1949.
Pestalotia mangiferae P. Henn. Ann. Mus. Congo Belge V. Fasc. II. 120. 1907.
Pestalotia funerea Desm. f. *mangiferae* Sacc. Atti. Istit. Veneto Sci. VI, **2** : 461. 1884.
Pestalotia virgatula Kleb. Mykol. Zbl. **4** : 13. 1914.

- Pestalotia pauciseta* Sydow, Ann. Myc. **15** : 265. 1917.
7. *Pestalotiopsis palmarum* (Cke.) Steyaert, Bull. Jard. Bot. Brux. **19** : 322. 1949.
Pestalotia palmarum Cke. Grevillea **4** : 115. 1875.
Pestalotia phoenicis Vize, Grevillea **5** : 14. 1876.
Pestalotia brevipes Prillieux and Celaeroix, Bull. Soc. Myc. France **10** : 84-85. 1894.
Pestalotia palmicola Sacc. & Syd. in Sacc. Syll. Fung. **14**: 1030. 1899.
8. *Pestalotiopsis theae* (Sawada) Steyaert. Bull. Jard. Bot. Brux. **19** : 327. 1949.
Pestalotia theae Sawada Spec. Rept. Agri. Exp. Sta. Taiwan, Formosa. **11** : 113. 1915.

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Reinvestigation into the reported instances of paternal and maternal inheritance in *Fragaria*¹

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The genus *Fragaria* with a large number of species occurs in polyploid series as natural diploids, tetraploids, hexaploids and octoploids. The most important among the diploids and octoploids are *F. vesca* L. ($2n=14$) and *F. virginiana* Duchesne ($2n=56$) respectively. *F. elatior* Ehrh. Beitr ($2n=42$) represents the only hexaploid species.

REVIEW OF LITERATURE

Millardet (1894) crossed various species of *Fragaria* such as (a)² "Fraisier des quatre saison blanc" $\times$ "Globe" (b)³ "Fraisier des Alpes" $\times$ "Ananas" (c)⁴ "Black Hautbois" $\times$ "Gaillon rouge" (d)⁵ "Black Hautbois" $\times$ "Chill velu" and obtained hybrids which, in most cases, resembled either the female or the male parent. He designated these hybrids as "faux hybrids." From the results of his experiments he postulated that a novel mode of inheritance occurs in the genus *Fragaria*, in which the hybrids show either the characters of the female parent or those of the male.

Solms-Laubach (1907) obtained 37 sterile descendants, all of the paternal type, in crosses, *F. virginiana* (8x) $\varnothing \times F. elatior$ (6x) σ .

Mangelsdorf and East (1927) criticised the hypothesis of Millardet. They interpreted the occurrence of the 'maternals' and 'paternals' in species crosses as a result of either pseudogamy or pollination by nearby *Fragaria* plants. They explained the occurrence of the 'paternals' from their knowledge of the chromosome numbers of various species of *Fragaria* which had been published by Longley (1926) and Ichijima (1926) in the previous year. They observed that in the crosses in which plants of paternal type arose, the male parents had the higher chromosome numbers and they considered that the dominance of the parent with higher chromosome numbers would occur in the crosses involving species of different chromosome numbers.

In diploid-octoploid crosses between *F. vesca* var. Belle de Meaux and *F. chiloensis*, Longley (1926) found a few individuals of the maternal

1. Condensed from a part of the thesis submitted to the Manchester University for the degree of Doctor of Philosophy.

2. Presumably diploid $\times$ octoploid.

3. Diploid $\times$ octoploid.

4. Hexaploid $\times$ diploid.

5. Hexaploid $\times$ octoploid.

type with seven bivalents in the PMCs and one plant of the paternal type with 28 bivalents at the first metaphase of meiosis. He used these data to support 'Millardet's hypothesis in the following words, "Parthenogenesis and the not-well-understood phenomenon patrogenesis are instrumental in the origin of false hybrids that completely resemble one or the other parent."

All the F_1 plants Ichijima (1930) obtained from reciprocal crosses between *F. vesca* and *F. elatior* were of the maternal type with the same chromosome number as the female parent. While not excluding the possibility of diploid parthenogenesis, he suggested that 'maternals' were probably the results of accidental selfing.

Yarnell (1931) obtained similar results using the same parents, *F. vesca* and *F. elatior* in reciprocal diploid-hexaploid crosses. None of the F_1 s showed a hybrid constitution either in their morphology or in their chromosome number.

In crosses between *F. vesca* and *F. chiloensis* (8x) and *F. vesca* and *F. virginiana*, Ichijima (1930) obtained nine plants of the maternal type with 14 chromosome and one of the paternal type with 56 chromosomes. To explain the presence of a 56-chromosome plant he ruled out the possibility of contamination by seeds. According to him, this plant supported strongly Millardet's (1894) hypothesis that paternals arise in species crosses of *Fragaria*. He further elaborated Millardet's points in the following words, "The chromosomes of the male nucleus may develop in the ovule to the complete exclusion of the female nucleus in an individual of the paternal type. Frequently the occurrence of doubling of the chromosome number in microsporocytes may furnish a possibility of producing a diploid condition in the paternal plants described above."

Yarnell (1931) crossed pink flowered *F. vesca* × white flowered octoploid *F. glauca*. His F_1 s consisted of 3 kinds of individuals (1) normal pentaploids, (2) 2 octoploid plants closely resembling the male parent and (3) 3 weekly growing diploids one of which bore white instead of pink flowers. To explain the occurrence of the white flowered exceptional diploid he postulated a hypothesis which is as follows:

'Only seven of the 28 chromosomes of the male gamete united with the normal 7 chromosome female gamete to give rise to this exceptional diploid plant; during syngamy the remaining 21 chromosomes of the male gamete got lost in the cytoplasm.' He could not put forward any cytological evidence in support of his conclusion. Three years later East (1934) also reached a similar conclusion on the results of his crosses described below.

In addition to normal hybrids, East (1930 and 1934) obtained a red fruited diploid maternal in a cross between a white fruited *F. vesca* and a red

fruited *F. virginiana*. The maternal differed from the female parent in the following characters:

- (1) noticeable heterosis,
- (2) lower pollen fertility,
- (3) non-dehiscing anthers,
- (4) red fruits,
- (5) smaller amount of dentation on central leaflet,
- (6) stouter rootstocks.

The F_2 progeny of this plant consisted of 18 plants, two of which were triploids, eight were sterile and the remaining three did not flower in three years of growth.

According to him this abnormal plant originated by either (a) mutation ;

or (b) contamination of *virginiana* pollen grain with that of red fruited *F. vesca* ;

or (c) due to a different mode of fertilisation in which seven of the 28 chromosomes of *F. virginiana* united with a normal gamete of *F. vesca*. He supported the last alternative because of the pollen sterility of this exceptional plant. East's arguments are plausible but in the absence of some unmistakable cytological evidence, e.g., observation of the process of fertilisation, this explanation cannot be accepted unreservedly. It may also be noted here that 2 red fruited *F. vesca* plants were in flower in the same greenhouse when East made this particular cross.

In the hexaploid-octoploid crosses between *F. elatior* var. Arabka and *F. grandiflora* var. Ziger, Saskina and Saskin (1940) obtained only plants of the maternal type. They also reported the preponderance of 'maternals' in the octoploid-diploid crosses between *F. grandiflora* and *F. collina*. From the reciprocal cross in which a pollen mixture from a number of varieties of *F. grandiflora* was used, they obtained six plants one of which was of the maternal type and the remaining five were of the paternal type.

EXPERIMENT

A survey of literature thus revealed that the question of 'paternal' and 'maternal' inheritance was still open. Accordingly crosses were made between diploid and octoploid species under strictly controlled conditions in order to confirm the findings of the previous workers.

Precautions

The precautions listed by Mangelsdorf and East (1927) and a few more were taken. These precautions included:

- (1) Only two plants, the male and female parents, were brought at

a time into the laboratory where emasculation and pollination were done.

(2) The flowers of the pollen parents were also enclosed in gelatin capsules before they opened. When these carefully protected flowers opened, the capsules were removed and the pollen from these flowers only was used. This precaution ensured that pollen used did not contain any foreign pollen which might have come from the air or from visiting insects.

(3) The pollinated flowers were not only covered with gelatin capsules but only one female plant containing the crosses was kept at a time inside a small greenhouse provided with double doors.

(4) Seeds were removed one at a time from a fruit immediately after harvest and sown directly into a seed pan containing sterilized soil. The chances of contamination from storage and later sowing were thus eliminated.

At a later stage of the experiment when a number of crosses had already been made, it was felt absolutely essential to use a compound microscope to examine all the emasculated anthers. The reason why such precaution was taken is described below:

During the course of the investigation, it was felt that some of the sessile anthers in the inner whorl of a *F. vesca* flower might burst during emasculation when they were held with a pair of forceps and so cause selfing.

It was also thought that microscopical examination of the emasculated anthers might reveal minute rupturing of the anther walls undetectable with a simple hand lens; and indeed on examination with the microscope, some of the emasculated anthers which had looked intact under a simple hand lens, showed slight rupturing of their anther walls with one or two pollen grains lying externally.

To verify that accidental selfing may occur during emasculation, six emasculated flowers were left unpollinated after being enclosed in capsules; in three of them the anthers were examined with a hand lens and in the remaining three, with a compound microscope. Of the three flowers which appeared uninjured when examined with a hand lens, two were found to set a very small nubbin fruit with one or two seeds and the third formed no seeds, while all the three flowers, in which the anthers were examined with a compound microscope and were found not to have dehisced, withered without forming any seeds. Thus to eliminate any possibility of accidental selfing, a compound microscope was used to examine the emasculated anthers in all the subsequent crosses.

Crosses made in 1952

In the crosses in which microscopical examination of the emasculated anthers was not made eight diploid 'maternal' appeared among a progeny of 62 plants.

In the subsequent crosses in which microscopical examination was made, no maternal appeared in a population of 46 plants.

Chromosome counts made at random from 5 plants showed that they all contained 35 chromosome the sum of chromosome number of male and female gamete; none of these plants appeared identical with the male parent and all of them without exception were completely sterile.

Crosses made in 1953

Crosses were repeated in 1953. A white fruited *F. vesca* var. Bush White was used in place of red-fruited *F. vesca* in order to check the report of East (1934) on the question of occurrence of diploid hybrid in the progeny of crosses between a white-fruited *F. vesca* and the cultivated octoploid types. It has already been mentioned earlier that according to East the presence of a red-fruited *F. vesca* in crosses, white-fruited *F. vesca* × red fruited octoploid is due to a novel type of hybridity in which 21 of the 28 chromosomes of the male gamete do not take part in fertilisation, the fusion nucleus being formed by the union of remaining 7 chromosomes of such gamete and 7 of the normal female gamete.

Sixteen crosses were made in 1953 between the diploid *F. vesca* var. Bush White and octoploids under strictly controlled conditions. Twenty-four F_1 s were obtained and none of them appeared either 'maternal' or 'paternal.' Chromosome counts ($2n=35$) also proved their hybrid nature beyond doubt.

The results of the 1953 crosses confirmed those of 1952 in that no plants of either 'maternal' or 'paternal' type appeared in the F_1 of diploid × octoploid crosses when these were made under strictly controlled conditions.

Experimentally produced pentaploids containing 3 genomes of F. vesca

In order to prove that 'paternals' arise not due to a different mode of inheritance but as a result of dominance of the parent with higher chromosome number, a few pentaploids were experimentally produced containing 3 genomes of *F. vesca* and 2 of *F. grandiflora* cultigens. To raise pentaploids, first of all tetraploid *F. vesca* was produced with colchicine treatment and this was crossed with the octoploid. This cross gave rise to hexaploids containing four genomes of the octoploid parent and the two of *F. vesca*. As expected, in almost all the characters these hexaploids showed dominance of the octoploid parent. Pentaploids were then produced by crossing c-tetraploid *F. vesca* with the experimentally produced hexaploids described

above. As one would expect these pentaploids (Figs. 1 and 2) resembled

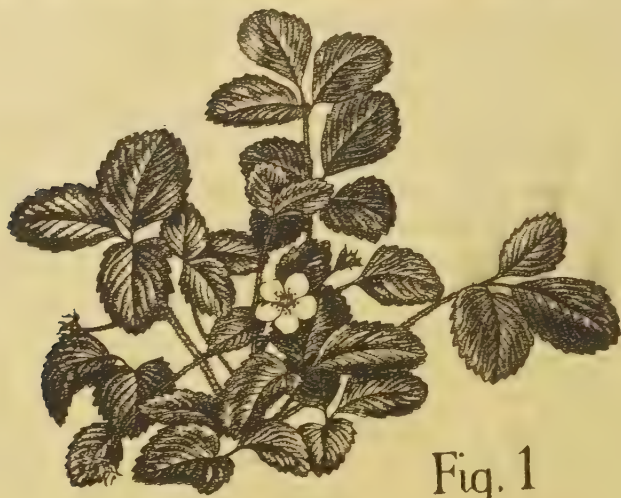


Fig. 1

A pentaploid hybrid from a cross, *F. vesca* (diploid) $\times$ octoploid cultigen. The hybrid greatly resembles the octoploid parent as it contains 4 genomes of the octoploid parent.



Fig. 2.

A pentaploid hybrid from a cross c-tetraploid *F. vesca* $\times$ experimentally produced hexaploid (F_1 of c-tetraploid *F. vesca* $\times$ octoploid). The hybrid greatly resembles *F. vesca* as it contains 3 genomes of it.

F. vesca closely as these contained three genomes of *F. vesca* and two of the octoploid parent. Except for the irregular serration in the leaves of the pentaploids, the resemblance was so close that one would mistake these for c-tetraploid *F. vesca*.

Thus these experimentally produced pentaploids lends strong support to Mangelsdorf and East's (1927) view that Millardet's 'paternals' were the result of dominance of the male parent with the higher chromosome number.

DISCUSSION

Plants of the paternal type have been reported to arise in intergeneric and interspecific crosses in addition to the *Fragaria* cases already discussed. Some examples are listed in Table I.

TABLE I
EXAMPLES OF PLANTS OF PATERNAL TYPE

Authority	PARENTS		Chromosome number of the plants of the paternal type
	Female	Male	
Burbidge (1877) ...	Venus Victrix a hort. variety of <i>Fuchsia</i> . ($2n=44$)	<i>Fuchsia serratifolia</i> ($2n=22$)	Not known
Solms-Laubach (1907)	<i>Fuchsia cordifolia</i> ($2n=22$)	<i>F. splendens</i> ($2n=22$)	Not known
Collins and Kempton (1916).	<i>Tripsacum dactyloides</i> ($2n=36, 72$)	<i>Euchlaena mexicana</i> ($2n=20$)	Not known
Bleier (1929) ...	<i>Lens esculenta</i> ($2n=14$) ...	<i>Vicia faba</i> ($2n=12$)	12
Clausen and Lammerts (1929).	Amphidiploid of (<i>Nicotiana glutinosa</i> $\times$ <i>N. tabacum</i>) ($2n=72$)	<i>N. tabacum</i> ($2n=48$)	24
Kostoff (1942) ...	<i>N. tabacum</i> var. <i>macrophylla</i> ($2n=72$)	<i>N. langsdorff</i> ($2n=18$)	9
ditto ...	F_1 of (<i>N. tabacum</i> $\times$ <i>N. sylvestris</i>) ($2n=36$)	<i>N. sylvestris</i> ($2n=24$)	12

Of these examples only those reported by Kostoff (l.c.) and Clausen and Lammerts (l.c.) were unquestionably proved to be plants of androgenetic origin (i.e. plants that develop from a male nucleus only), since these contained the gametic chromosome number of the male parent.

In discussing Millardet's examples of plants of the paternal types in diploid-octoploid crosses, it is now possible to make use of cytological information not available to Millardet himself. Later findings (Ichijima,

1930; Yarnell, 1931) have shown that the male parent in Millardet's crosses in which 'paternals' appeared was a higher polyploid and that the somatic chromosome numbers of these 'paternals' were the sum of the gametic chromosome numbers of both the parents. In only three cases were the individuals found to have the same somatic chromosome number as the male parent.

Millardet's plants of the paternal type in diploid-octoploid species crosses were, therefore, the result of dominance of the male parent with higher chromosome number, as suggested by Mangelsdorf and East (1927) and confirmed by the cytological observations of Ichijima (1930) and Yarnell (1931) and not of the type reported in species crosses of *Nicotiana* (Kostoff, 1942; Clausen and Lammerts, 1929). The dominance of the characters of *F. vesca* in the pentaploid hybrids obtained in the present investigation from crosses. c-tetraploid *F. vesca* $\times$ synthetic hexaploids (F_1 of c-tetraploid *F. vesca* $\times$ octoploid) containing three genomes of *F. vesca* and two of the octoploid parent strengthens the supposition of Mangelsdorf and East (1927).

OCCURRENCE OF 56-CHROMOSOME PLANTS IN DIPLOID-OCTOPOID CROSSES

Ichijima (1930) suggested that plants of paternal type with 56 chromosomes originated either entirely from the male nucleus, the chromosomes of which became doubled at an early stage of embryo development or from seed contamination.

The absence of any 56-chromosome plants in the present investigation leads one to think, particularly in the absence of more convincing proofs such as the observation of chromosome number in the pollen tube, study of the behaviour of chromosomes of the male and female gametes and actual observation of the extrusion of the chromosomes of the female gamete during fertilisation and the subsequent stages of embryo development, that perhaps the 56-chromosome-plants in the diploid-octoploid cross, reported by earlier workers, were the results of seed contamination. Until a plant of paternal type with the gametic chromosome number of the male parent is obtained in diploid-octoploid crosses, this question must remain open.

MATERNAL INHERITANCE

In many previously reported cases the appearance of maternals was undoubtedly due to insufficient protection of the flowers after pollination. For instance, Ichijima (1930) did not protect his flowers from chance pollination. He stated that in making these crosses all pollinations were carried out without employing bagging and pollen in all the *Fragaria* species is extremely small and easily carried by air currents. It is possible that these plants (maternals) might have resulted from accidental selfing or from contamination by pollen of similar species.

Although Millardet (1894) took great pains in his crosses to exclude the chances of self-pollination and other sources of contamination (e.g. covering the plant with a cage after pollination and placing it on a saucer filled with water to prevent ants from reaching the flowers), in the light of present investigation these precautions were not sufficient to exclude all possibility of self-pollination. It has been shown that the sessile anthers of innermost whorl stand a great chance of being slightly injured during emasculation, this injury being undetectable with a hand lens.



Fig. 3.

The haploid strawberry *F. vesca* derived from a cross, *F. vesca* $\times$ *octoploid* cultigen.

Fig. 4. ($\times 1440$)

Photomicrograph of a root-tip cell of the haploid showing seven somatic chromosomes $\times 1440$.

It is highly probable from the results of the present experiments, and from the fact that the more rigorous the precautions the lower the frequency of maternals, that the occurrence of the maternal offspring bearing the same chromosome number as the female parent in species crosses in the result of accidental selfing. A case of parthenogenesis was recorded in the present investigation, but this on chromosome count proved to be a haploid parthenogenesis (Figs. 3 and 4) and not a diploid one (Islam, 1956). The possibility of diploid parthenogenesis, however, is not ruled out. In the present investigation a hexaploid arose from a cross between diploid and octoploid. This hexaploid have in all probability originated from an unreduced female gamete fertilised by a reduced male gamete. This non-reduction of the female gamete might rarely give rise to a diploid parthenogenetic plant. The results of the present investigation therefore clearly indicate that diploid parthenogenesis, if at all occurs, is rare and does not occur with the frequency reported by the previous workers.

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Brevibucca punctata, n. sp. and *Macrolaimus natator*, n. sp.,
New Soil Nematodes from East Pakistan

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Large numbers of a new species of *Brevibucca* Goodey, 1935 were collected from rotting portions of the intact roots of a banana plant in January, 1961. About 100 females and 50 males were recovered. The species is chiefly of interest because of a stomatal feature not previously reported for the genus. Because of the punctate longitudinal lines on the body it is named *Brevibucca punctata*, n. sp.

A single male specimen of a new species of *Macrolaimus* Maupas, 1900 was obtained from around the roots of a pineapple plant in November, 1959. The species is unusual in the forward extent of the preanal papillae. Because of its extremely rapid vibratile motion in water it is named *Macrolaimus natator*, n. sp.

Brevibucca punctata, n. sp. (Fig. 1, C-H)

The measurements are based on specimens fixed by gentle heating in tap water, but the measurements of the type specimens are of glycerine mounts.

20 females: $L=1.12-1.67$ mm. (1.39); $a=31.5-44$; $b=4.3-6.1$; $c=2.9-4.5$; $v=60.5-73.5\%$.

20 males: $L=0.7-0.88$ mm. (3.8); $a=25-34$; $b=3.5-4$; $c=8-9.7$.

Holotype female: $L=1.44$ mm.; $a=24.3$; $b=5.6$; $c=3.8$; $v=70\%$.

Allotype male: $L=0.72$ mm.; $a=35.7$; $b=4.1$; $e=8.2$.

Description: Body tapering toward head end. Cuticle very finely striated; about 50 subcuticular longitudinal lines composed of fine punctations, one for every two transverse striae. Head continuous with body contour; lips set off from each other. Inner circle of 6 tiny apical papillae surrounding stoma and outer circle of 6 distinct labial papillae near extreme anterior. Aphids transversely elliptical or dome-shaped, with prominent duct leading from amphidial pouch and curving slightly dorsal; amphids situated at first third of stoma. Stoma 14μ deep in female, $9-13\mu$ in male, about 1.7 times longer than wide. Prorhabdions thick, expanded at base, dorsal wall slightly thickened near anterior; meso- and

metarhabdions represented by small sclerotized thickenings at ends of oesophageal radii, connected by transverse bars to each other to form a complex valvar apparatus. Oesophagus consisting of broad corpus with swollen base but not in form of bulb, long, narrow isthmus, and valvate terminal bulb. Excretory pore $102-112\mu$ from anterior in female (40%), $83-92\mu$ in male (45%), well anterior to base of corpus; prominent sclerotized terminal excretory duct; small excretory sinus cell at base of terminal bulb. Short, flat oesophago-intestinal valve. Intestine with fine yellowish inclusions, darker at anterior; rhabditin crystals lacking.

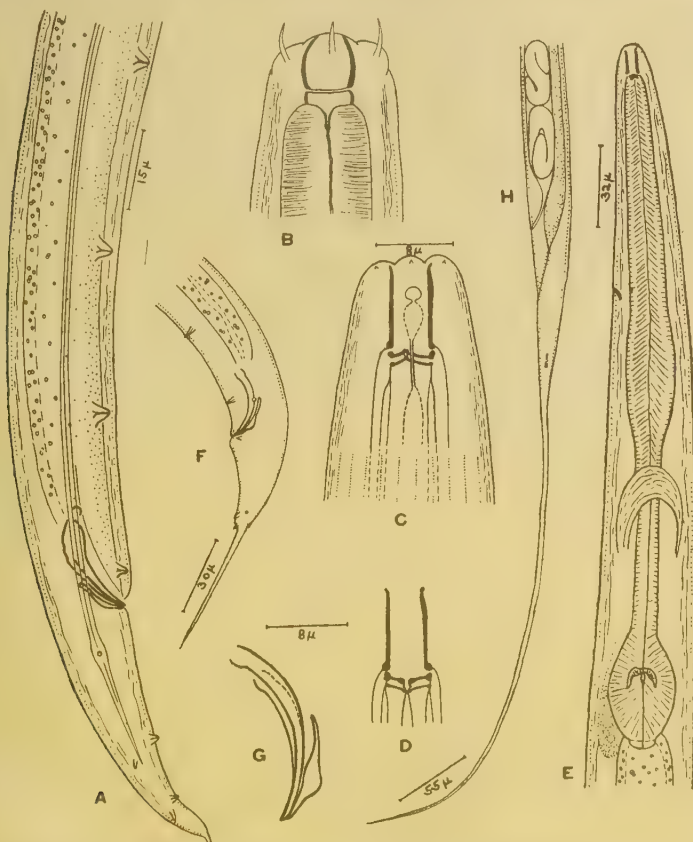


Fig. 1.—A-B, *Macrolaimus natator*, n. sp. A, male tail; B, male head. C-H, *Brevibucca punctata*, n. sp. C, male head; D, view of male stoma opposite oesophageal radius; E, female oesophageal region; F, male tail; G, male copulatory apparatus; H, female tail.

Female: Ovary single, prodelphic, extending in some females almost to oesophagus, reflexed 27-50% of length. Vulva just anterior to anus; uterine glands absent. Spermatheca apparently set off by constriction at distal end of uterus. Up to 23 ova in uterus at a time, about $50 \times 20 \mu$; up to 10 ova embryonated; larvae active before ovulation but no evidence of hatching inside body. Tail conical-filiform with pointed tip, 14.6-21.8 anal body diameters long. Phasmids distinct at juncture of conical and filiform parts of tail, with prominent innervation.

Male: Testis single, reflexed about 2 anal body diameters, obscure in life due to dark colour of anterior part of intestine. Spicules cephalated, unequal; right spicule $23-27 \mu$ long across arc, left spicule $27-31 \mu$. Gubernaculum $18-22 \mu$, bulging posterior at base. Copulatory bursa absent. Two pairs of prominent subventral preanal papillae; 1 pair lateral papillae at mid-spicules; 1 pair adanal; 2 tiny pairs just anterior to tail spike; and 1 pair subventral and subdorsal papillae at beginning of tail spike. Small lateral phasmids opposite the 2 pairs of tiny papillae. Tail $1/3$ conical, $2/3$ spicate, 4.2-5.5 anal body diameters long.

Holotype female: Collected 21 January, 1961 by R. W. Timm; personal collection Slide S 52.

Allotype male: Same data as holotype; Slide S 53.

Paratypes (males and females): Slides S 54-57.

Type habitat: Rotting root of banana (*Musa paradisaca* L).

Type locality: Notre Dame College, Dacca, East Pakistan.

Discussion: *Brevibucca* Goodey, 1935 was placed in the Rhabditinae by Goodey. In the type species *B. saprophaga* Goodey, 1935 the male tail lacks a bursa and the female has a single ovary. In *B. frugicola* Goodey, 1943 the male tail has a bursa and the female has paired ovaries. Chitwood (1950), Osche (1952), and Dougherty (1953) retained *Brevibucca* in the Rhabditinae. Later Dougherty (1955) tentatively relegated it to uncertain status within the Rhabditinae but in an addendum to his paper placed it in a new subfamily, the poikilolaiminae, based on the shortened stoma and apparent absence of glottoid apparatus. He remarked that this subfamily tends to bridge the gap between the Rhabditidae and Cephalobidae. The finding of a complex glottoid apparatus in the present species, in which the male is the same as *Brevibucca saprophaga* in other respects, forces removal of *Brevibucca* from the Poikilolaiminae. However, it does not settle its affinities with certainty. The presence of a glottoid apparatus would seem to indicate the *Brevibucca* belongs in the Rhabditinae, but the apparatus is

more complex than in the recognized genera of rhabditins, being composed of both meso- and metastom elements. Moreover, there is an absence of sphaerocrystal inclusions of the intestine, which seem to be characteristic of rhabditins. The postlabial elliptical amphids are reminiscent of the Diplogasteridae, but a valvate oesophageal bulb is lacking in that family. In my opinion *Brevibucca* bridges the gap between the Rhabditidae and Cephalobidae even more closely than Dougherty supposed. The presence of meso- and metarhabdions would suggest affinities with the Panagrolaminae and especially with the genus *Macrolaimus*, Maupas 1900, in which the base of the corpus is usually swollen; however, a single prodelphic ovary reflexed most of its length is the rule in the Panagroliminae. Because of the presence of a copulatory bursa in the male of *Brevibucca frugicola* and the possession of a glottoid apparatus, however complex, in the present species, I prefer to regard *Brevibucca* as belonging to the Rhabditinae.

The present species differs from *B. saprophaga* Goodey, 1935 in the punctate longitudinal lines, more anterior excretory pore, larger stoma and much longer tail in the female, and shorter spicules and gubernaculum in the male.

***Macrolaimus natator*, n. sp. (Fig. 1, A-B)**

The measurements are of a glycerine-jelly mount.

1 male: L=0.81 mm.; $a=37$; $b=5.4$; $c=17$.

Female unknown.

Description: Body tapering only slightly anteriorly. Cuticle very finely striated; 3 distinct lateral lines, set close together. Head continuous with body contour, somewhat truncate at anterior. Lips slightly set off. Labial papillae not observed; 6 incurved labial setae, about 35% head diameter long. Amphids not observed. Sclerotized stoma 7μ deep and 4μ wide; distinct division between cheilostom and prostom; cheilorhabdions 3 times as long as prorhabdions; thickened lining surrounded by anterior of oesophagus probably represents fused meso-, meta-, and telorhabdions. Oesophagus consisting of corpus with swollen base, narrow isthmus, and valvate terminal bulb. Excretory pore opposite anterior of terminal bulb. Testis single 59% of body length, reflexed 40μ anteriorly; primary spermatocytes in single row; secondary spermatocytes in double row of staggered cells. Spicules 28μ long or 1.6 anal body diameters, cephalated, with internal division distally; velum present. Gubernaculum 11μ long, parallel to spicules. Eight pairs genital papillae plus phasmids; 4 subventral pairs equally spaced anterior to anus; 2 subventral and 2 subdorsal pairs on

posterior half of tail. Phasmids conspicuous, 1/2 anal body diameter posterior to anus; lateral lines curve around phasmids. Tail conical with blunt finger-like tip curved dorsally; tail 3 anal body diameters long. Holotype male: Collected on 10 November, 1959 by M. Ameen; personal collection Slide S 58.

Type habitat: Soil around the roots of pineapple (*Ananas sativus* Schult.).

Type locality: Aminbagh, Dacca, East Pakistan.

Discussion: This species differs from all other species of *Macrolaimus* in the presence of three lateral lines. In the proportion of the two parts of the stoma and the tail hook it resembles *M. hamatus* Thorne, 1937, which has no lateral lines. The two anteriormost pairs of genital papillae are not found in any other species for which males are known.

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Brief Notes

A NOTE ON THE NEMATODE PARASITES OF BIRDS

In her paper entitled "The nematode parasites of the birds of Hyderabad (India)", published in *Biologia*, 6 (1), 1960, Dr. Suraiya Rasheed has deemed it advisable to redescribe *Acuaria brevispicula* Maplestone because, according to her, the description of this species had, till now, been based on a single male only. Her own studies are based only on one male and one female worm. It is surprising that she would not refer to my paper on "Some spirurid and filariid nematodes of birds in Pakistan" (*J. Helminth.* London, 30 (2/3), 1956, wherein I had described this species, basing my account on no fewer than 12 male and 7 female specimens collected from a different host. I should have assumed that she was not aware of my work, were it not for the fact that my abovementioned paper did receive a mention in the Introduction to her paper. It is unfortunate that my paper failed to find a place in her list of references also.

Dr. Suraiya Rasheed has referred to my suggestion, contained in the same paper, that *Acuaria kungi* Singh, 1948 might be a synonym of *A. brevispicula* Maplestone, 1932, but has chosen to dismiss it out of hand, although she has had access to the type material of *A. kungi*. Naturally, this interesting case of synonymy remains unsolved.

M. M. SARWAR

FURTHER CONTRIBUTIONS TO THE FUNGI OF WEST PAKISTAN—I

SOME CORRECTIONS

Dr. F. C. Deighton, of the Commonwealth Mycological Institute, has very kindly pointed out that in my paper with the above title which appears in the earlier pages (117-136) of this volume, two mistakes have crept in. It is sought to rectify them here.

I. The new generic name *Suttonia*, proposed for *Pseudoriospora* Petr. non Keissl., happens to be a later homonym of *Suttonia* A. Rich. (Myrsinaceae), 1832 (see Index Kewensis: not Hook. f. as given in Willis).

The name *Suttonia* being occupied, it is proposed that this genus be called *Suttoniella*. This change necessitates the following new combinations.

Suttoniella gaubae (Petr.) comb. nov.

Syn. *Suttonia gaubae* (Petr.) Ahmad in *Biologia*, 6 (2): 128, 1960.

Suttoniella eriobotryae (Ahmad) comb. nov.

Syn. *Suttonia eriobotryae* Ahmad in 6 *Biologia*, (2): 128, 1960.

II. *Uromyces sophorae*, a new species described on leaves of *Sophora alopecuroides* from Gilgit (*Biologia*, 6 (2): 125, 1960), turns out to be a homonym of *U. sophorae* Peck (*Bot. Gaz.*, 3: 34, 1878). The name **Uromyces gilgitae** nom. nov. is, therefore, proposed for it.

III. *Discosia jambolanae* sp. nov. (*Biologia*, 6 (2): 135, 1960).

Through oversight the type collection was not indicated. The collection on *Eugenia jambolanae* from Sialkot, 15-11-58, No. 14297, is the type collection.

SULTAN AHMAD

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